[redacted]

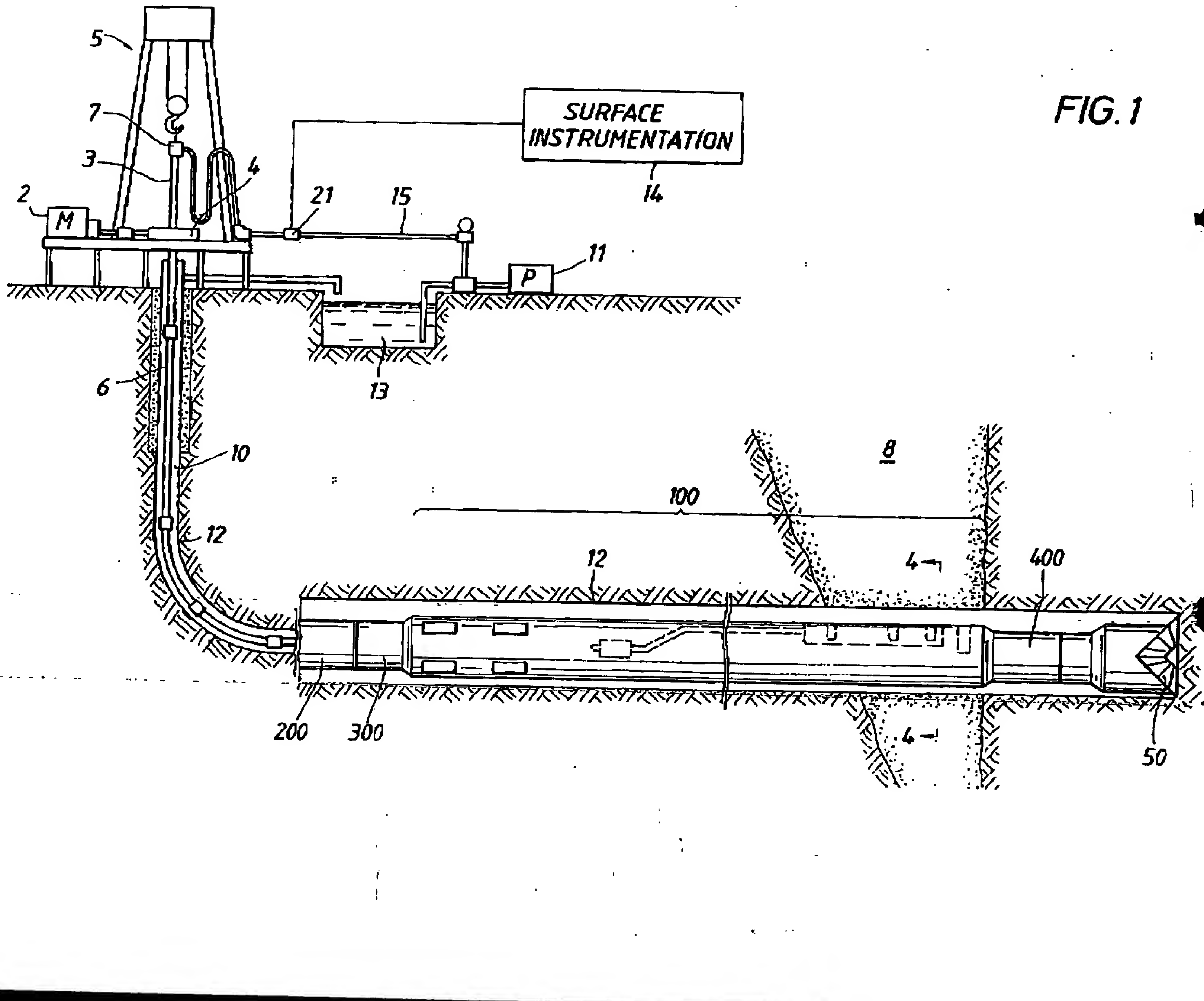
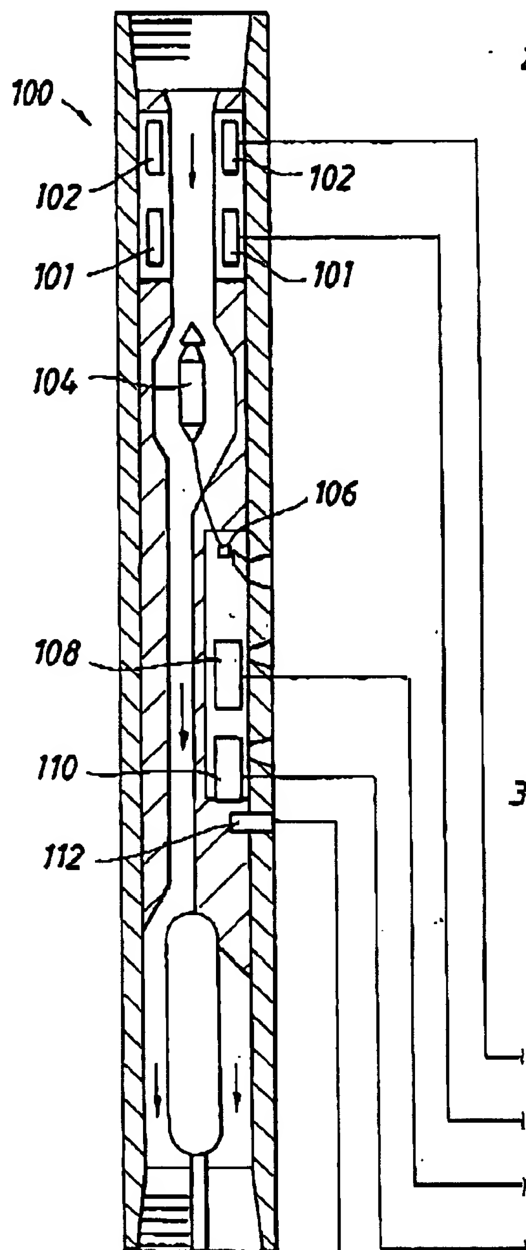


FIG. 1

FIG.2


100
102
102
101
101
104
106
108
110
112

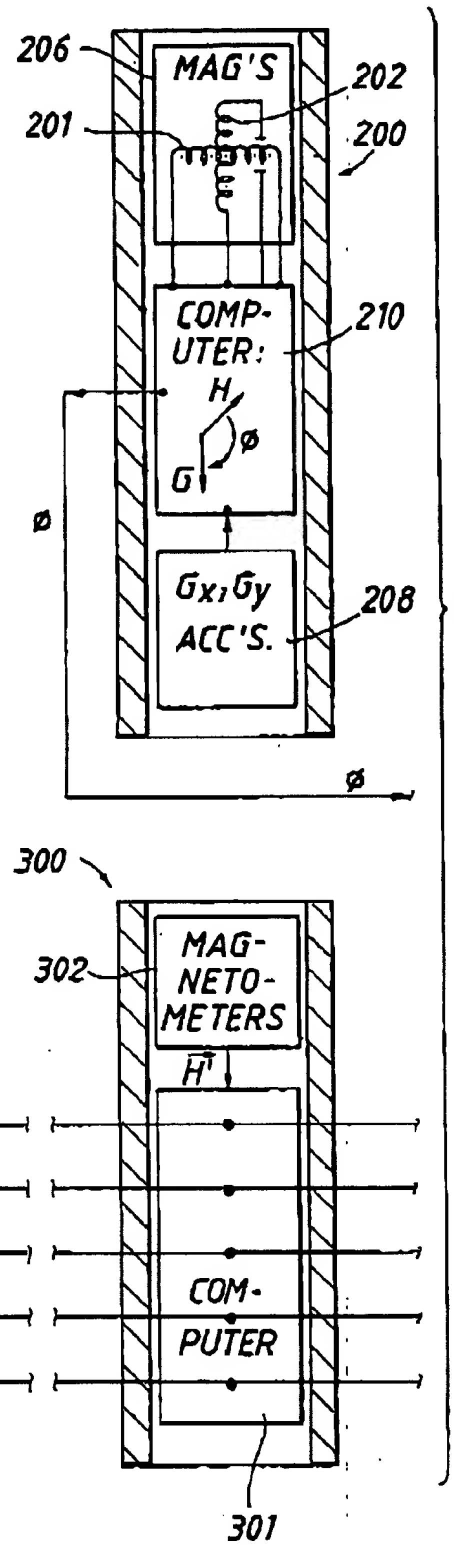

206
MAG'S
202
201
200
COMP-
UTER:
210
H
Ø
G
Ø
Gx, Gy
ACC'S.
208
Ø
300
MAG-
NETO-
METERS
302
H
COM-
PUTER
301

FIG.3A

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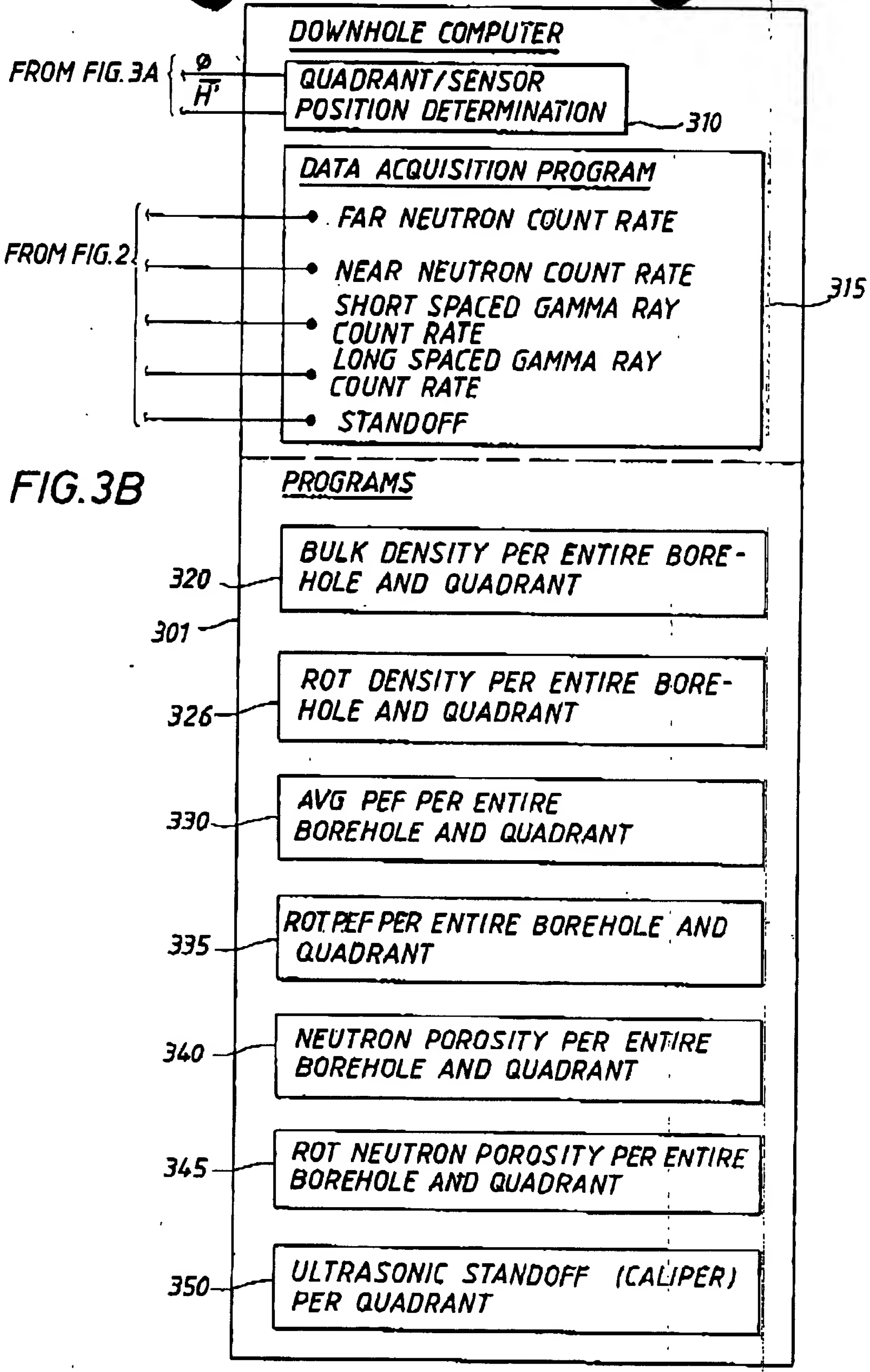


FIG.3B

FIG. 4A

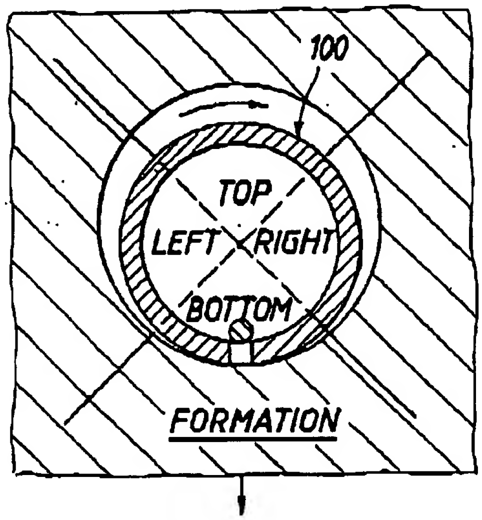
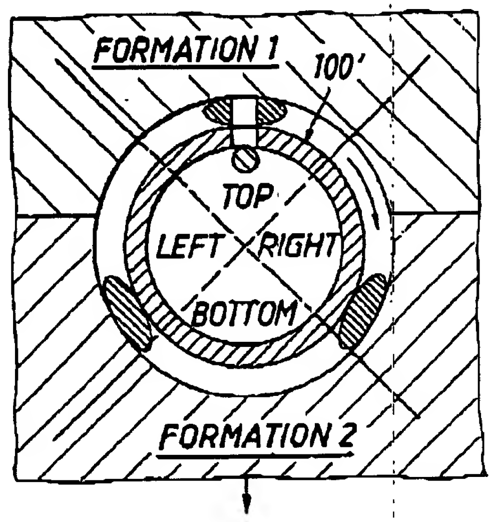


FIG. 4B



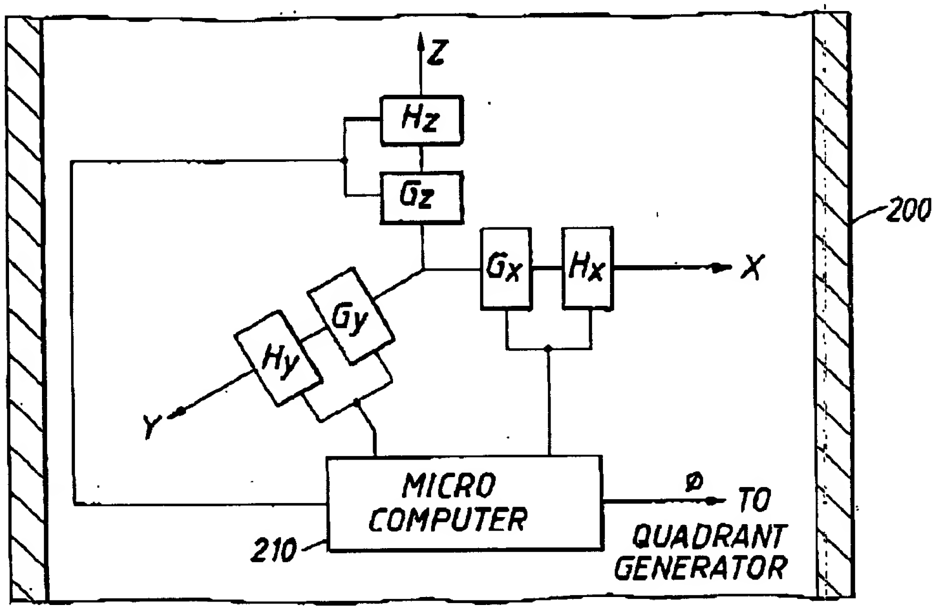


FIG. 5A

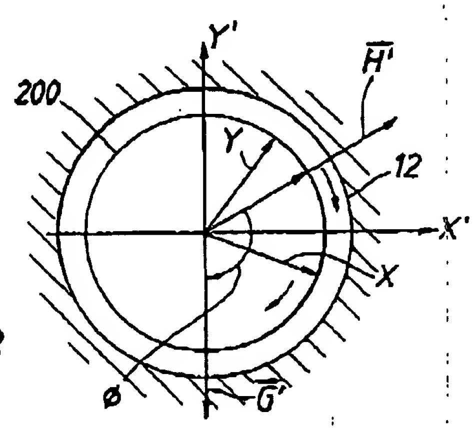


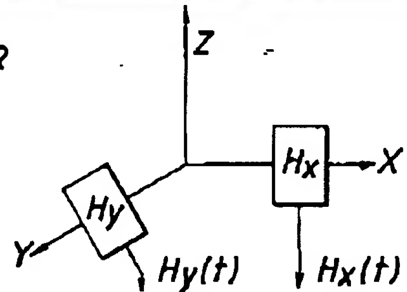
FIG. 5B

FIG. 6A

300

302

MAGNETOMETER SECTION



QUADRANT/SENSOR POSITION DETERMINATION COMPUTER PROGRAM

DETERMINE DOWN DIRECTION

- DETERMINE $\vec{H}'(t)$ VECTOR FROM $H_x(t)$, $H_y(t)$, $\angle\theta(t)$
- DETERMINE DOWN DIRECTION ANGLE

$$\theta = \cos^{-1} \frac{H_x(t)}{(H_x^2 + H_y^2)^{1/2}}$$

ø

$\angle\vec{H}(t) = \theta(t)$ AS MEASURED FROM TOOL X-AXIS

$\angle\vec{D}(t) = \theta(t) - \phi$ AS MEASURED FROM TOOL X-AXIS

- DETERMINE BOTTOM QUADRANT

310

$Q_{BOT}(t) = \angle\vec{D}(t) - 45°$ TO $\angle\vec{D}(t) + 45°$

$Q_{LEFT}(t) = \angle\vec{D}(t) + 45°$ TO $\angle\vec{D}(t) + 135°$

$Q_{TOP}(t) = \angle\vec{D}(t) + 135°$ TO $\angle\vec{D}(t) + 225°$

$Q_{RIGHT}(t) = \angle\vec{D}(t) + 225°$ TO $\angle\vec{D}(t) - 45°$

- DETERMINE QUADRANT OF SENSOR

$\angle\vec{S}(t)$ IS MEASURED FROM X-AXIS AND $\vec{H}'(t)$ VECTOR

$\angle\vec{S}$ IS α DEGREES FROM X-AXIS

$\angle\vec{H}(t)$ IS $\theta(t)$ DEGREES FROM X-AXIS

$\angle\vec{S}(t) = \alpha$ AS MEASURED FROM X-AXIS IS

IN Q_{BOT} WHEN $\angle\vec{S}(t) = \alpha$ IS BETWEEN $\theta(t) - \phi - 45°$ AND $\theta(t) - \phi + 45°$, ETC.

FIG.6B

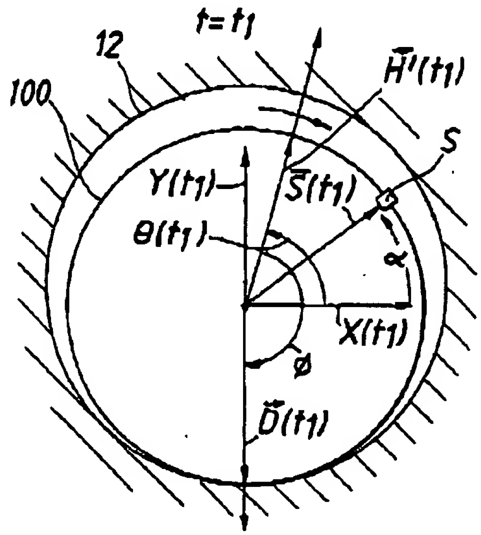
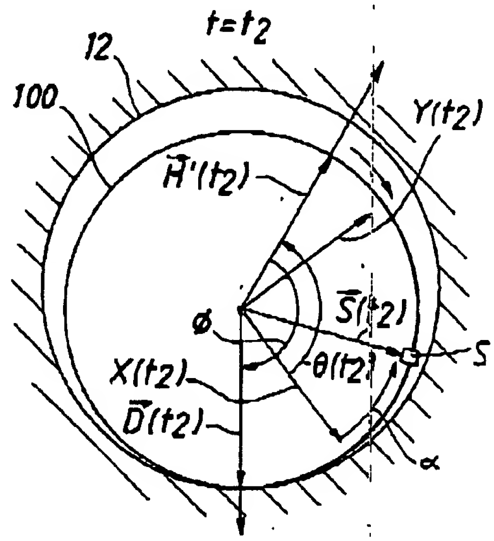


FIG.6C



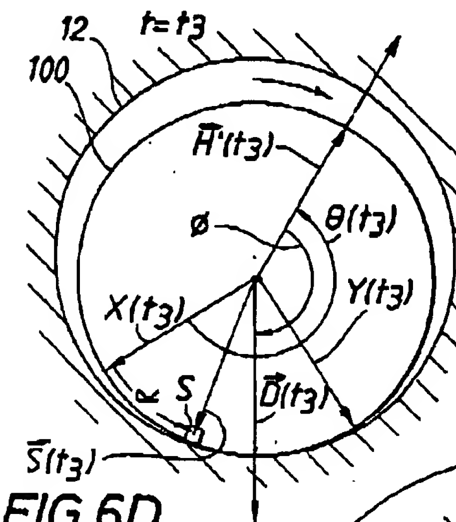


FIG.6D

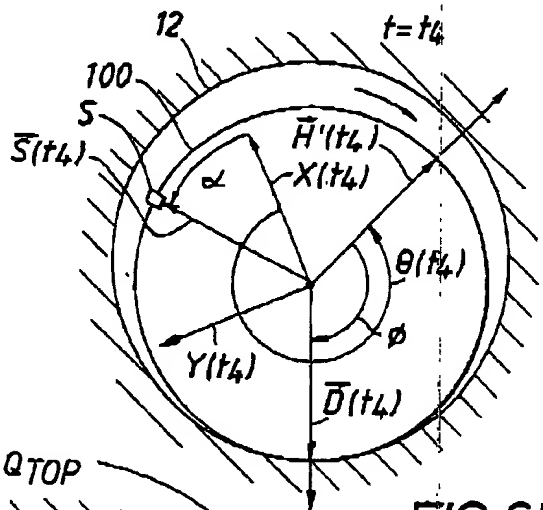


FIG.6E

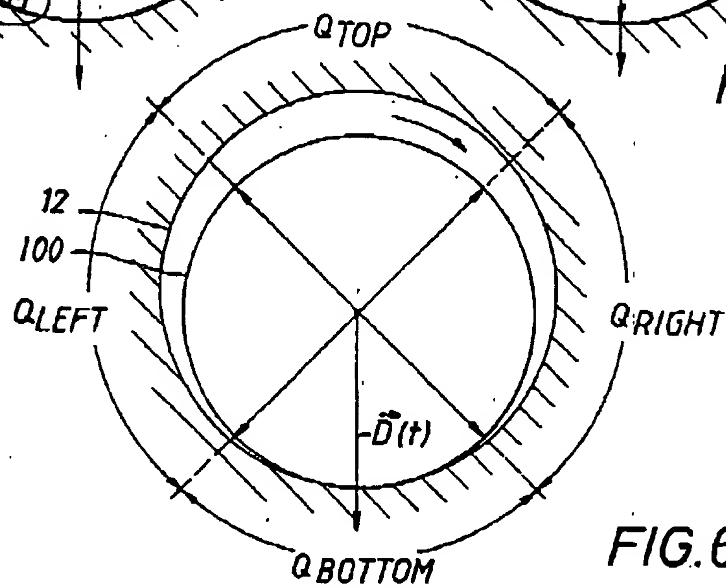


FIG.6F

FIG. 7A

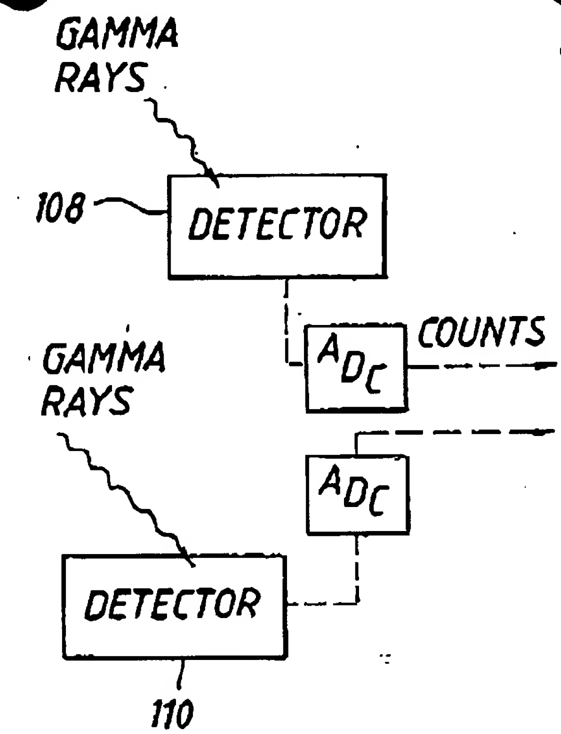
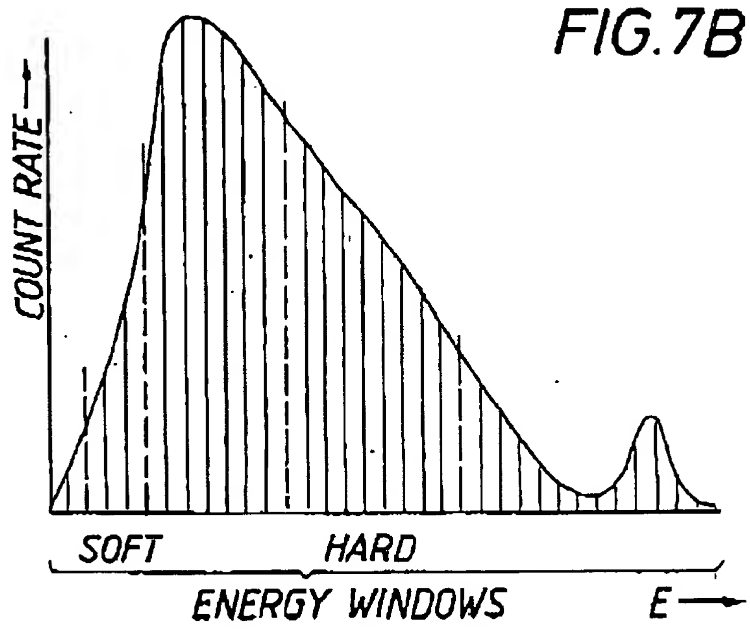

GAMMA
RAYS
108
DETECTOR
ADC
COUNTS
GAMMA
RAYS
ADC
DETECTOR
110

FIG. 7B


COUNT RATE
SOFT
HARD
ENERGY WINDOWS
E

09960445.092101

FIG.8

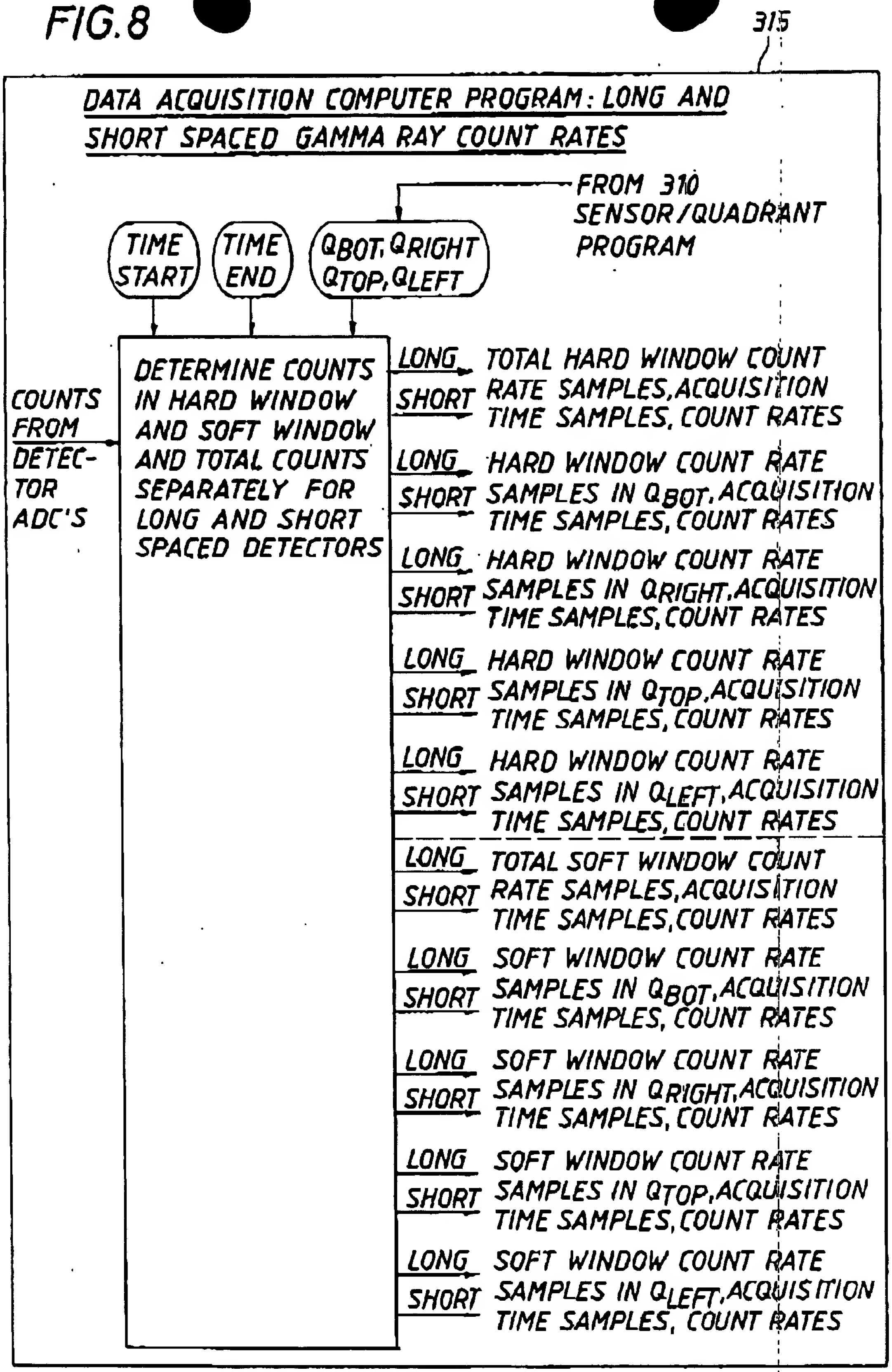


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FIG.9

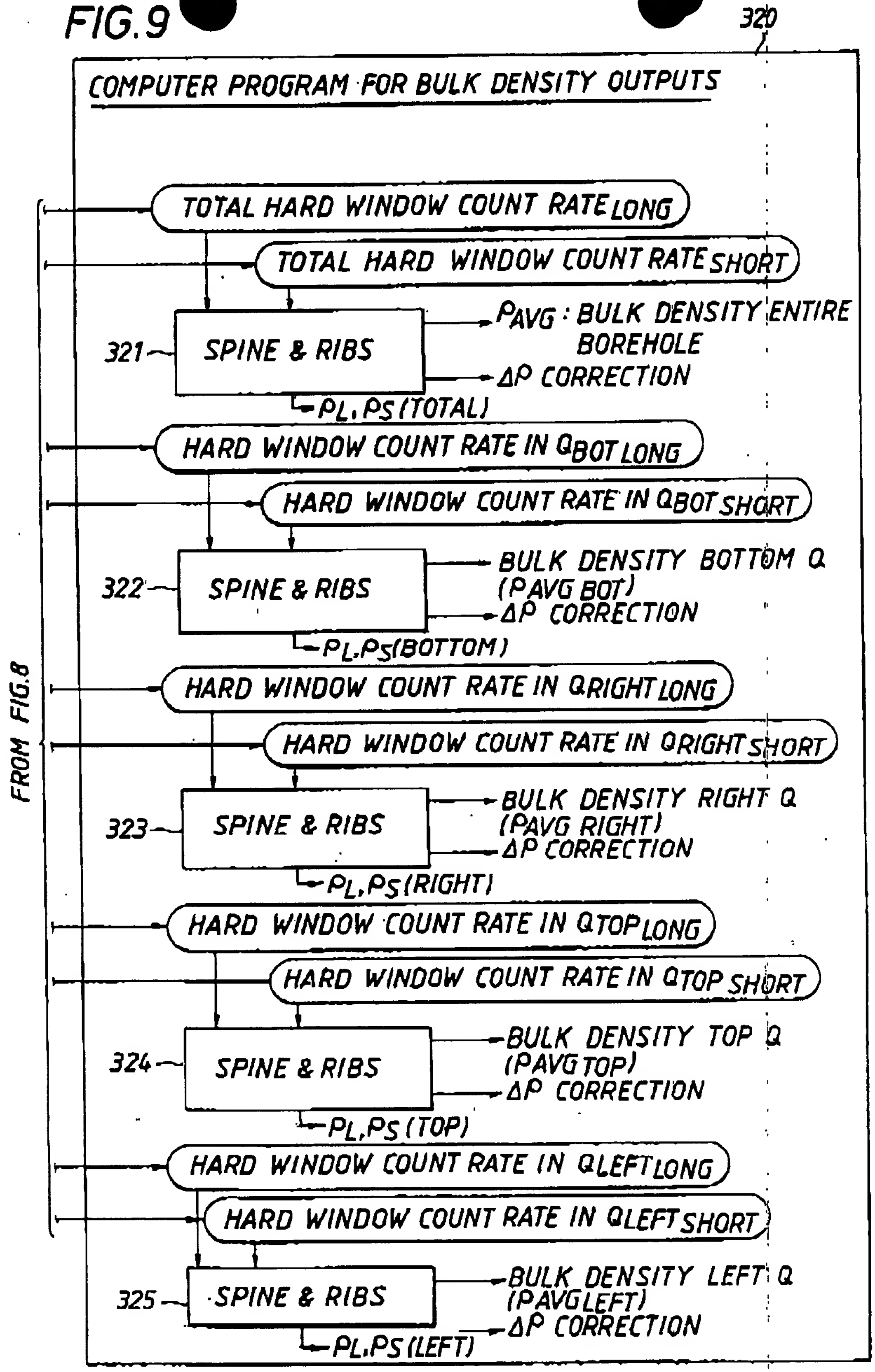


FIG. 10A-1

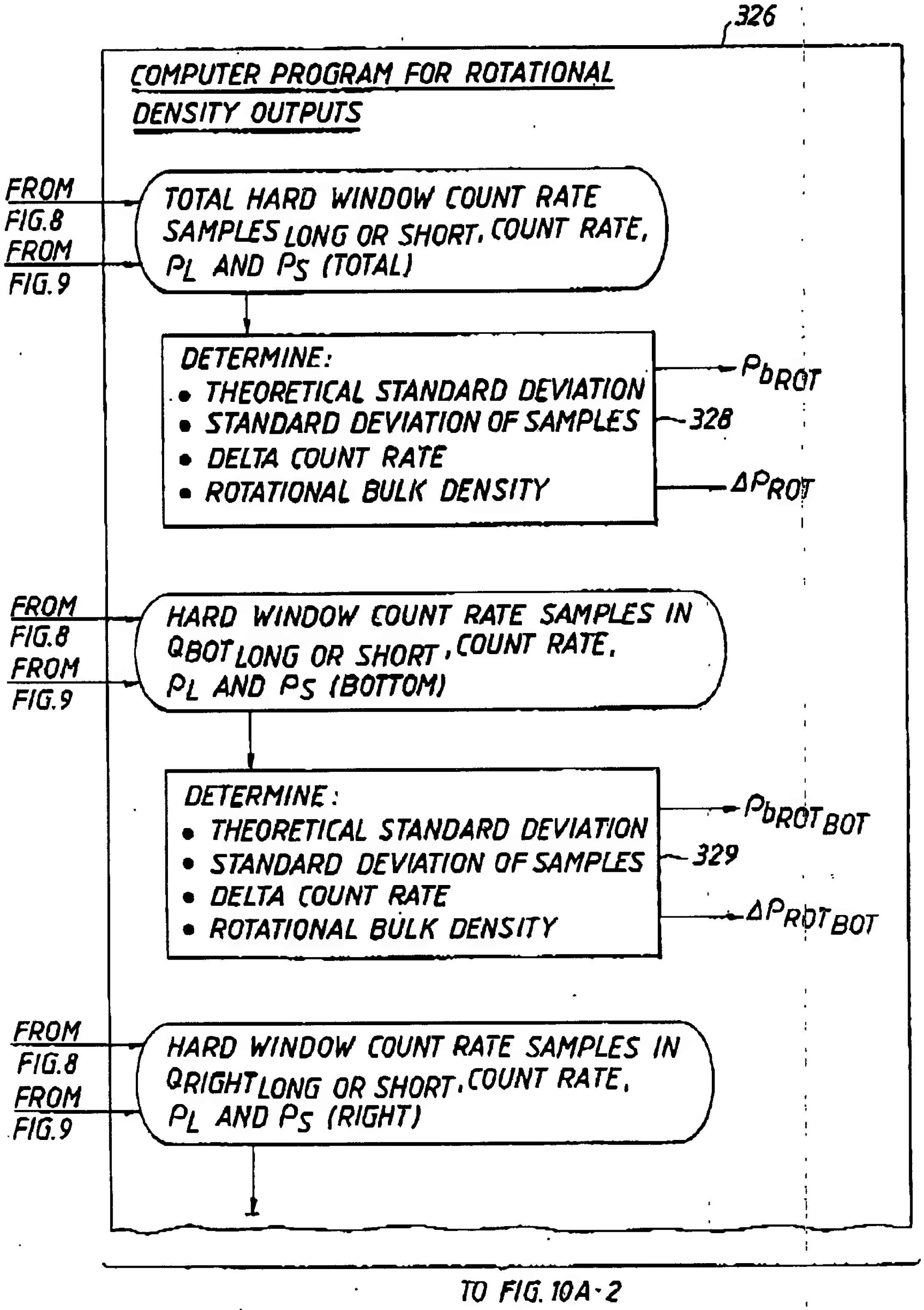
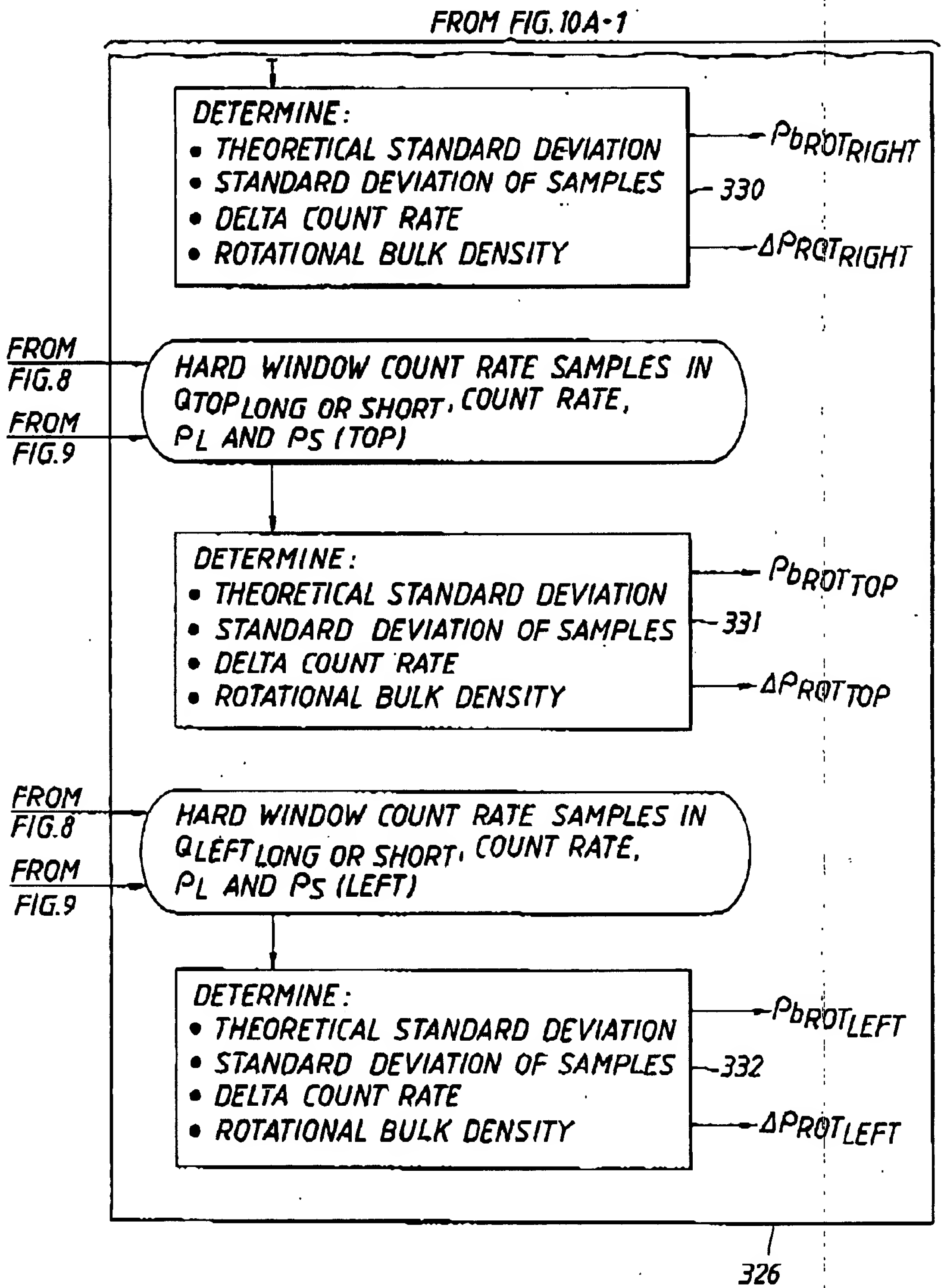

326
COMPUTER PROGRAM FOR ROTATIONAL DENSITY OUTPUTS
FROM FIG.8
FROM FIG.9
TOTAL HARD WINDOW COUNT RATE SAMPLES LONG OR SHORT, COUNT RATE, ρ_L AND ρ_S (TOTAL)
DETERMINE:
• THEORETICAL STANDARD DEVIATION
• STANDARD DEVIATION OF SAMPLES
• DELTA COUNT RATE
• ROTATIONAL BULK DENSITY
ρ_{bROT}
328
$\Delta\rho_{ROT}$
FROM FIG.8
FROM FIG.9
HARD WINDOW COUNT RATE SAMPLES IN QBOT LONG OR SHORT, COUNT RATE, ρ_L AND ρ_S (BOTTOM)
DETERMINE:
• THEORETICAL STANDARD DEVIATION
• STANDARD DEVIATION OF SAMPLES
• DELTA COUNT RATE
• ROTATIONAL BULK DENSITY
$\rho_{bROT\,BOT}$
329
$\Delta\rho_{ROT\,BOT}$
FROM FIG.8
FROM FIG.9
HARD WINDOW COUNT RATE SAMPLES IN QRIGHT LONG OR SHORT, COUNT RATE, ρ_L AND ρ_S (RIGHT)
TO FIG. 10A-2

FIG.10A-2


FROM FIG.10A-1
DETERMINE:
• THEORETICAL STANDARD DEVIATION
• STANDARD DEVIATION OF SAMPLES
• DELTA COUNT RATE
• ROTATIONAL BULK DENSITY
$\rho_{bROT_{RIGHT}}$
330
$\Delta\rho_{ROT_{RIGHT}}$
FROM FIG.8
FROM FIG.9
HARD WINDOW COUNT RATE SAMPLES IN $Q_{TOP_{LONG\ OR\ SHORT}}$, COUNT RATE, ρ_L AND ρ_S (TOP)
DETERMINE:
• THEORETICAL STANDARD DEVIATION
• STANDARD DEVIATION OF SAMPLES
• DELTA COUNT RATE
• ROTATIONAL BULK DENSITY
$\rho_{bROT_{TOP}}$
331
$\Delta\rho_{ROT_{TOP}}$
FROM FIG.8
FROM FIG.9
HARD WINDOW COUNT RATE SAMPLES IN $Q_{LEFT_{LONG\ OR\ SHORT}}$, COUNT RATE, ρ_L AND ρ_S (LEFT)
DETERMINE:
• THEORETICAL STANDARD DEVIATION
• STANDARD DEVIATION OF SAMPLES
• DELTA COUNT RATE
• ROTATIONAL BULK DENSITY
$\rho_{bROT_{LEFT}}$
332
$\Delta\rho_{ROT_{LEFT}}$
326

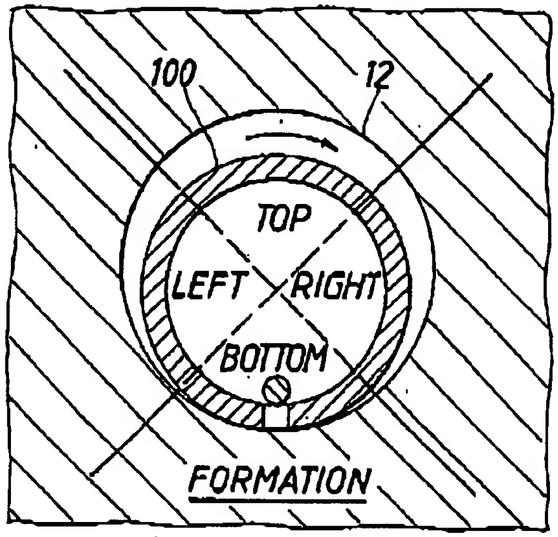


FIG.10B

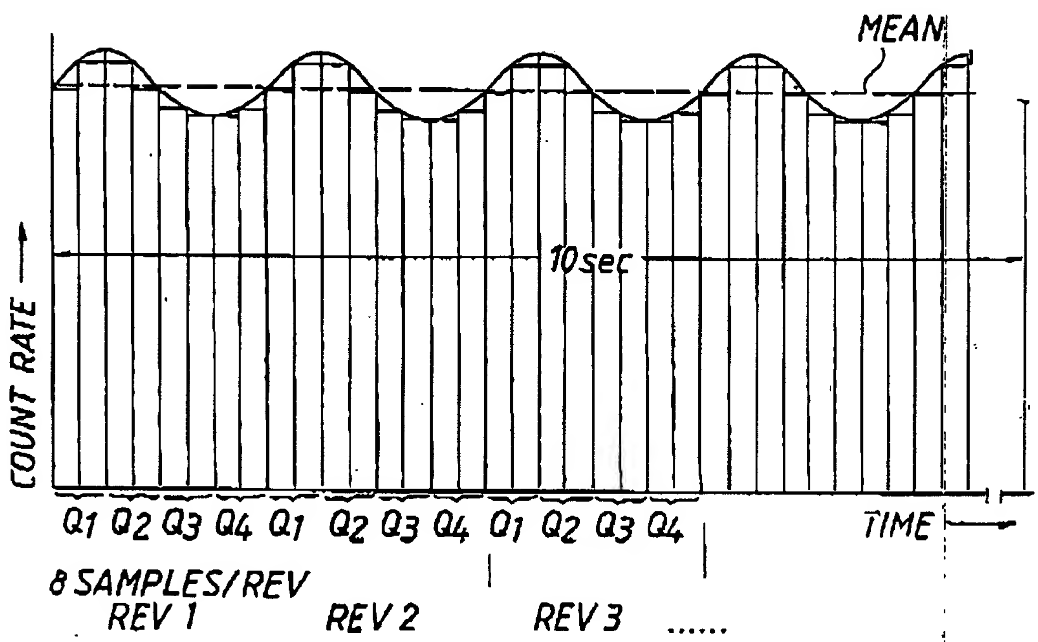
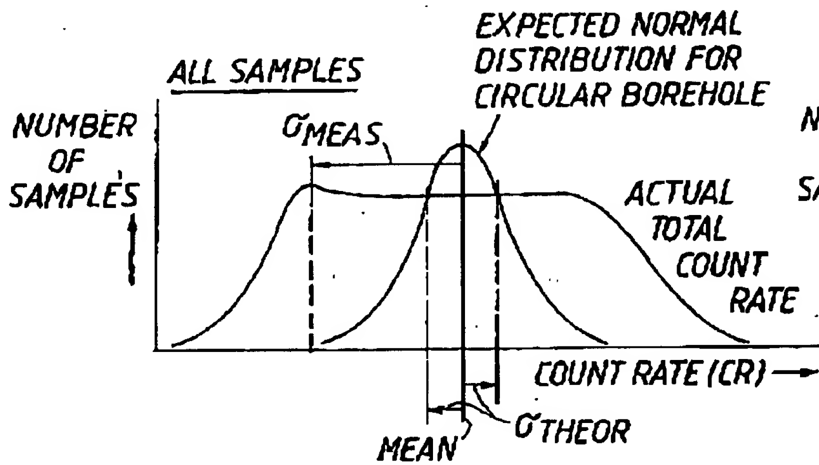


FIG.10C



$$\Delta CR = A\sqrt{\sigma^2_{MEAS} - \sigma^2_{THEOR}}$$

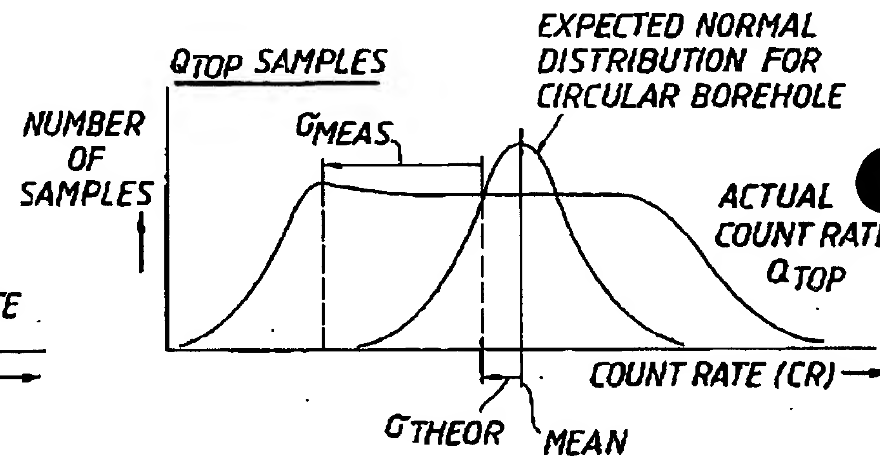
$$\Delta \rho_{ROT} = (ds)\left[\ln\left(\frac{CR + \Delta CR}{CR - \Delta CR}\right)\right]$$

$$\rho_{bROT} = D\rho_L + E\rho_S + F\Delta\rho_{ROT}$$

ρ_L = LONG SPACING DENSITY

ρ_S = SHORT SPACING DENSITY

FIG.10D-1



$$\Delta CR_{TOP} = A\sqrt{\sigma^2_{MEAS_{TOP}} - \sigma^2_{THEOR_{TOP}}}$$

$$\Delta \rho_{ROT_{TOP}} = (ds)\left[\ln\left(\frac{CR_{TOP} + \Delta CR_{TOP}}{CR_{TOP} - \Delta CR_{TOP}}\right)\right]$$

$$\rho_{bROT_{TOP}} = D\rho_{L_{TOP}} + E\rho_{S_{TOP}} + F\Delta\rho_{ROT_{TOP}}$$

$\rho_{L_{TOP}}$ = LONG SPACING DENSITY $_{TOP}$

$\rho_{S_{TOP}}$ = SHORT SPACING DENSITY $_{TOP}$

FIG.10D-2

FIG.11A

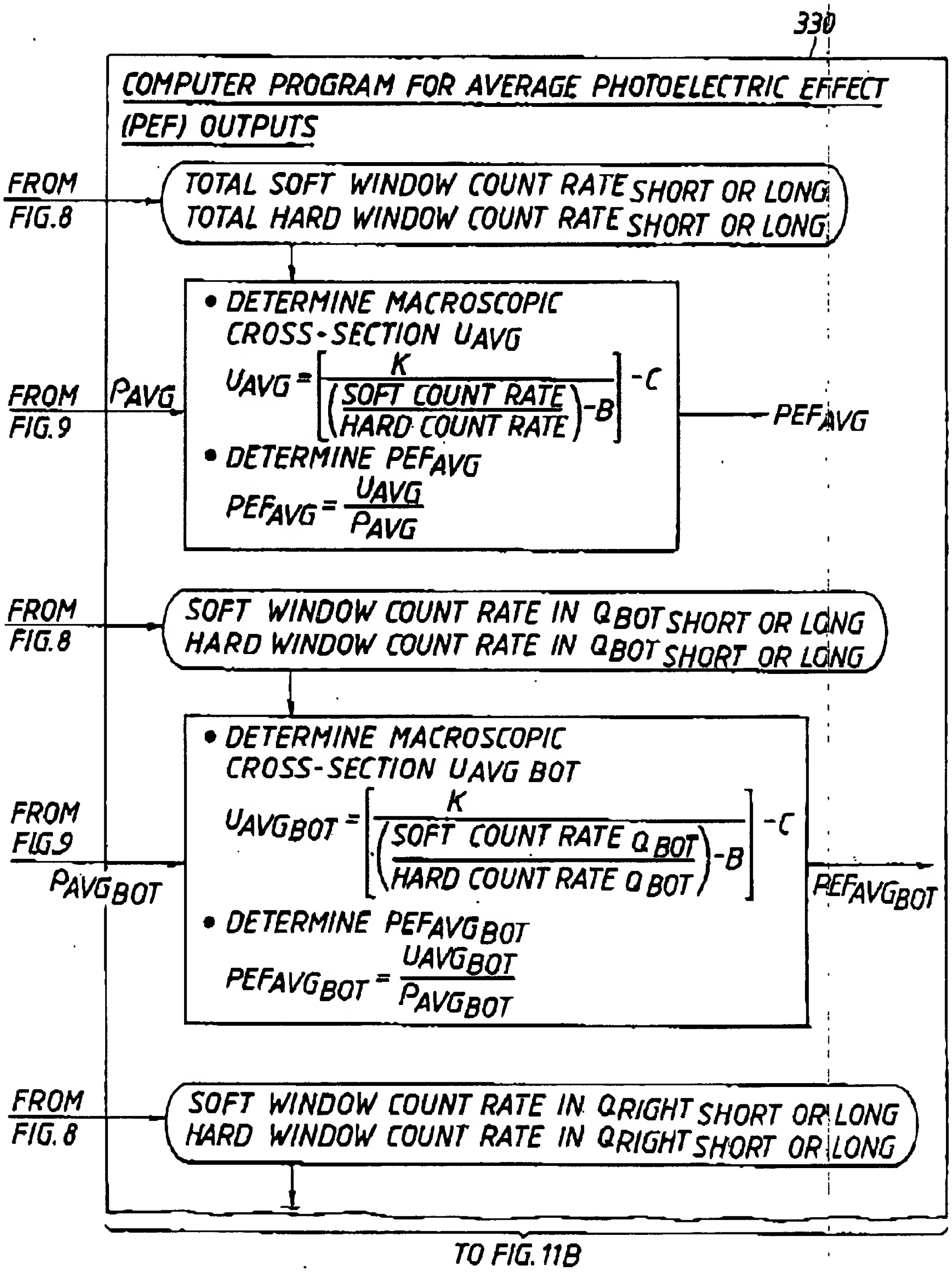

330
COMPUTER PROGRAM FOR AVERAGE PHOTOELECTRIC EFFECT (PEF) OUTPUTS
FROM FIG.8
TOTAL SOFT WINDOW COUNT RATE SHORT OR LONG
TOTAL HARD WINDOW COUNT RATE SHORT OR LONG
• DETERMINE MACROSCOPIC CROSS-SECTION UAVG
UAVG = [K / ((SOFT COUNT RATE / HARD COUNT RATE) - B)] - C
FROM FIG.9
PAVG
PEFAVG
• DETERMINE PEFAVG
PEFAVG = UAVG / PAVG
FROM FIG.8
SOFT WINDOW COUNT RATE IN QBOT SHORT OR LONG
HARD WINDOW COUNT RATE IN QBOT SHORT OR LONG
• DETERMINE MACROSCOPIC CROSS-SECTION UAVG BOT
UAVGBOT = [K / ((SOFT COUNT RATE Q BOT / HARD COUNT RATE Q BOT) - B)] - C
FROM FIG.9
PAVGBOT
PEFAVGBOT
• DETERMINE PEFAVGBOT
PEFAVGBOT = UAVGBOT / PAVGBOT
FROM FIG.8
SOFT WINDOW COUNT RATE IN QRIGHT SHORT OR LONG
HARD WINDOW COUNT RATE IN QRIGHT SHORT OR LONG
TO FIG.11B

FIG.11B

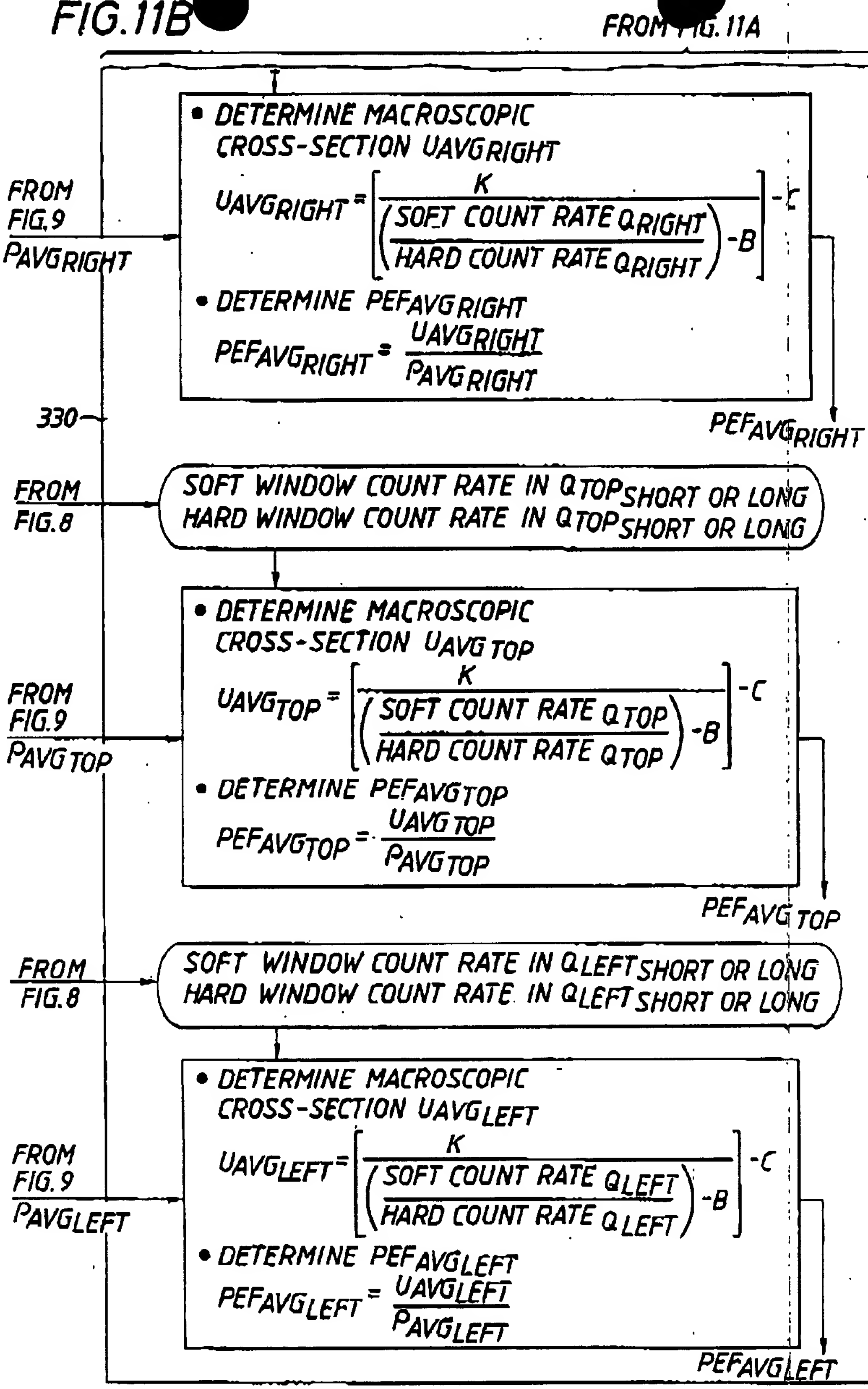
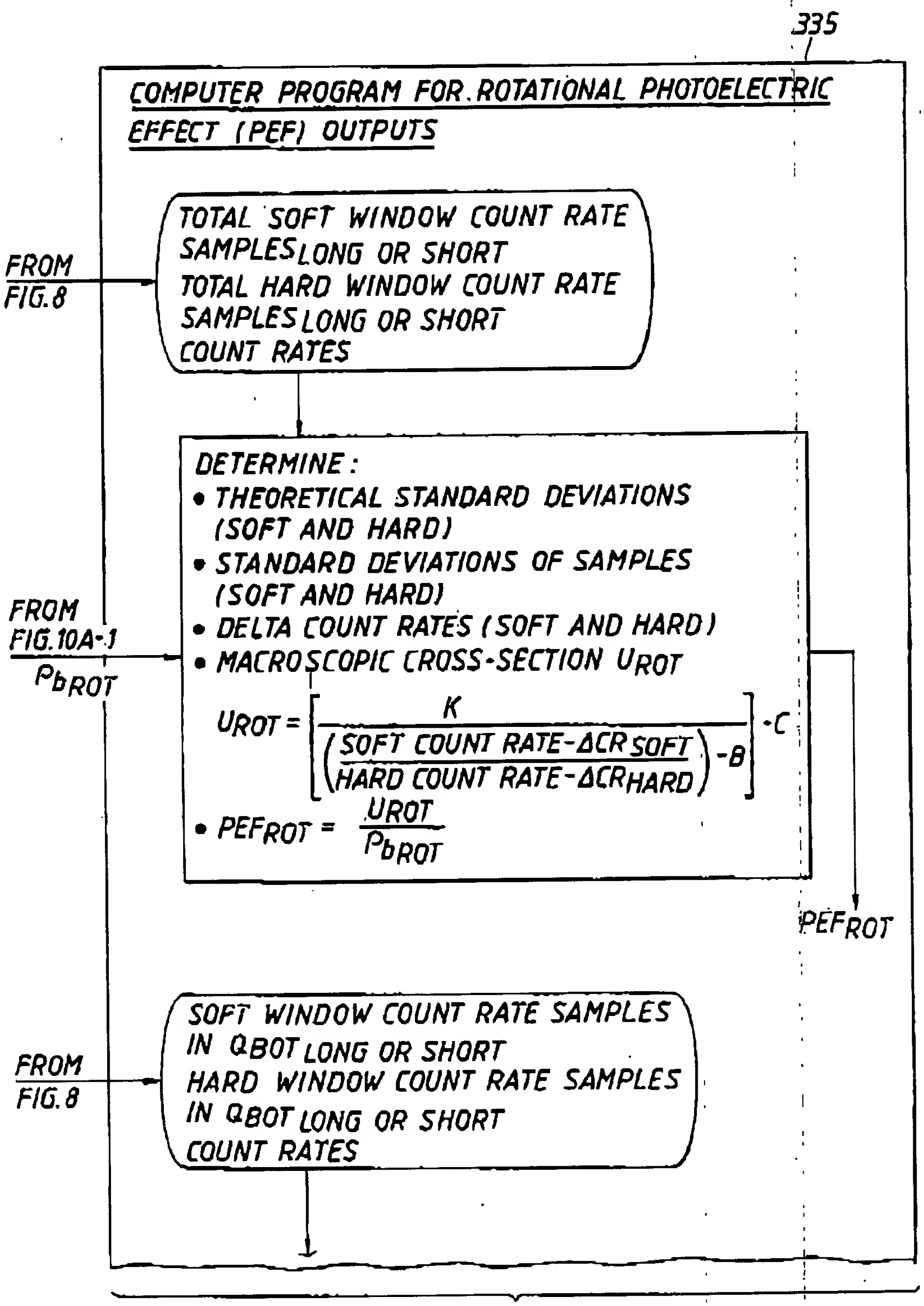

FROM FIG.11A
FROM FIG.9
PAVGRIGHT
• DETERMINE MACROSCOPIC CROSS-SECTION UAVGRIGHT
$UAVG_{RIGHT} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE } Q_{RIGHT}}{\text{HARD COUNT RATE } Q_{RIGHT}}\right) - B}\right]^{-C}$
• DETERMINE PEFAVGRIGHT
$PEF_{AVG_{RIGHT}} = \frac{UAVG_{RIGHT}}{PAVG_{RIGHT}}$
330
PEFAVGRIGHT
FROM FIG.8
SOFT WINDOW COUNT RATE IN QTOP SHORT OR LONG
HARD WINDOW COUNT RATE IN QTOP SHORT OR LONG
FROM FIG.9
PAVGTOP
• DETERMINE MACROSCOPIC CROSS-SECTION UAVGTOP
$UAVG_{TOP} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE } Q_{TOP}}{\text{HARD COUNT RATE } Q_{TOP}}\right) - B}\right]^{-C}$
• DETERMINE PEFAVGTOP
$PEF_{AVG_{TOP}} = \frac{UAVG_{TOP}}{PAVG_{TOP}}$
PEFAVGTOP
FROM FIG.8
SOFT WINDOW COUNT RATE IN QLEFT SHORT OR LONG
HARD WINDOW COUNT RATE IN QLEFT SHORT OR LONG
FROM FIG.9
PAVGLEFT
• DETERMINE MACROSCOPIC CROSS-SECTION UAVGLEFT
$UAVG_{LEFT} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE } Q_{LEFT}}{\text{HARD COUNT RATE } Q_{LEFT}}\right) - B}\right]^{-C}$
• DETERMINE PEFAVGLEFT
$PEF_{AVG_{LEFT}} = \frac{UAVG_{LEFT}}{PAVG_{LEFT}}$
PEFAVGLEFT

FIG. 12A



TO FIG. 12B

FIG.12B

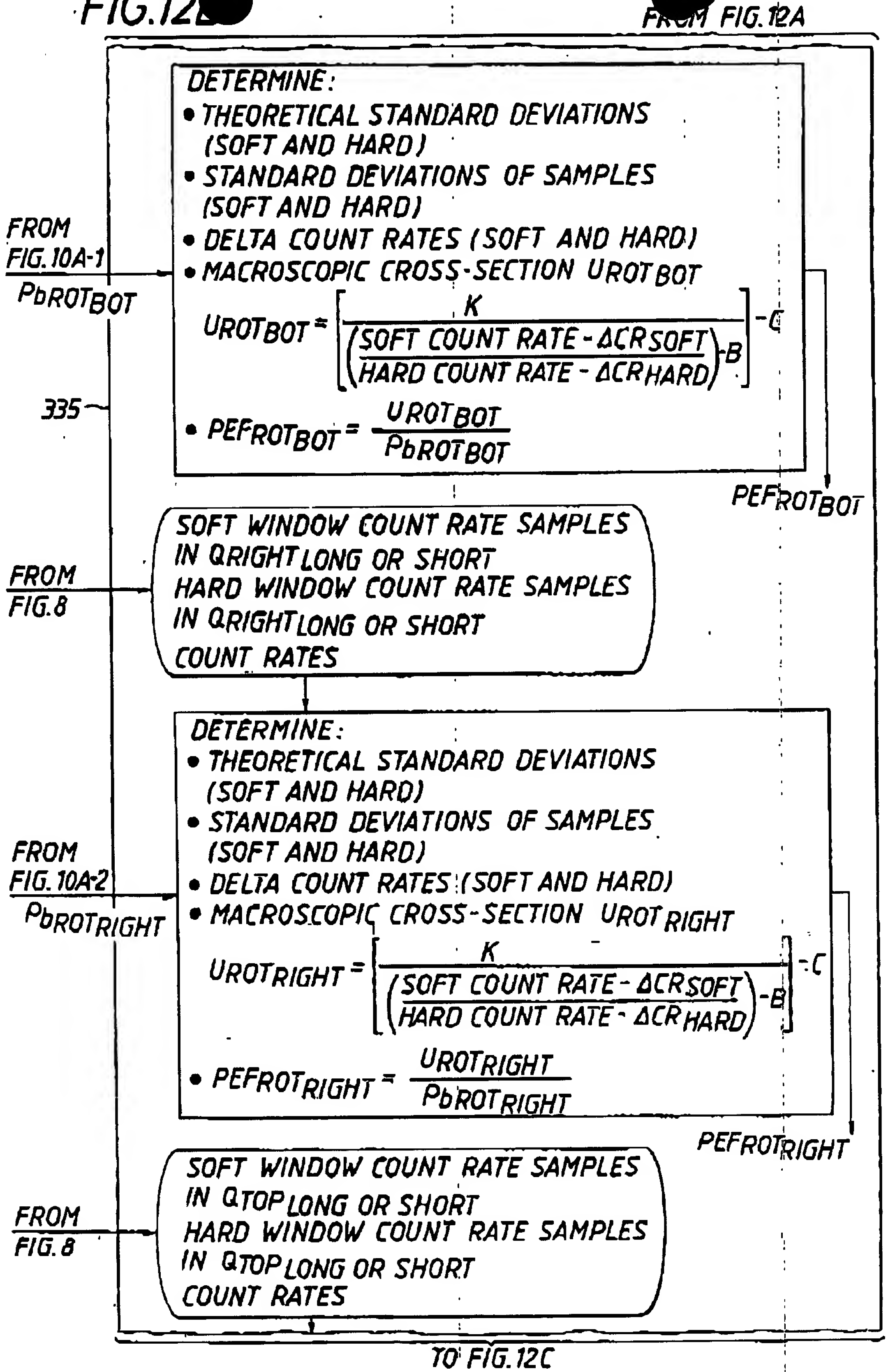

FROM FIG.12A
DETERMINE:
• THEORETICAL STANDARD DEVIATIONS (SOFT AND HARD)
• STANDARD DEVIATIONS OF SAMPLES (SOFT AND HARD)
• DELTA COUNT RATES (SOFT AND HARD)
• MACROSCOPIC CROSS-SECTION U_{ROTBOT}
$U_{ROTBOT} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE} - \Delta CR_{SOFT}}{\text{HARD COUNT RATE} - \Delta CR_{HARD}}\right) - B}\right] - C$
• $PEF_{ROTBOT} = \frac{U_{ROTBOT}}{Pb_{ROTBOT}}$
FROM FIG.10A-1
Pb_{ROTBOT}
335
PEF_{ROTBOT}
SOFT WINDOW COUNT RATE SAMPLES IN Q_{RIGHT} LONG OR SHORT
HARD WINDOW COUNT RATE SAMPLES IN Q_{RIGHT} LONG OR SHORT
COUNT RATES
FROM FIG.8
DETERMINE:
• THEORETICAL STANDARD DEVIATIONS (SOFT AND HARD)
• STANDARD DEVIATIONS OF SAMPLES (SOFT AND HARD)
• DELTA COUNT RATES (SOFT AND HARD)
• MACROSCOPIC CROSS-SECTION $U_{ROTRIGHT}$
$U_{ROTRIGHT} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE} - \Delta CR_{SOFT}}{\text{HARD COUNT RATE} - \Delta CR_{HARD}}\right) - B}\right] - C$
• $PEF_{ROTRIGHT} = \frac{U_{ROTRIGHT}}{Pb_{ROTRIGHT}}$
FROM FIG.10A-2
$Pb_{ROTRIGHT}$
$PEF_{ROTRIGHT}$
SOFT WINDOW COUNT RATE SAMPLES IN Q_{TOP} LONG OR SHORT
HARD WINDOW COUNT RATE SAMPLES IN Q_{TOP} LONG OR SHORT
COUNT RATES
FROM FIG.8
TO FIG.12C

FIG.1

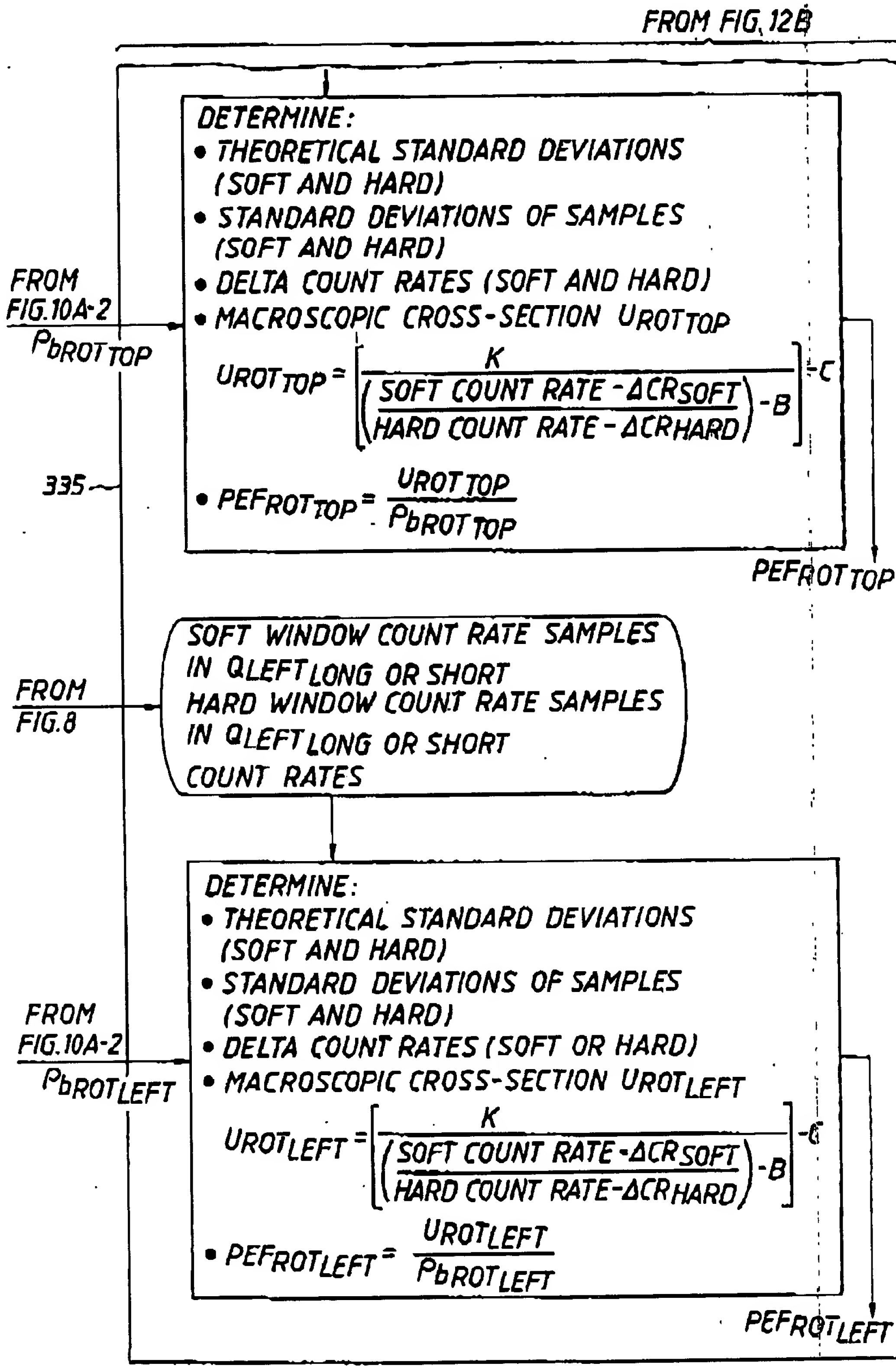

FROM FIG.12B
DETERMINE:
• THEORETICAL STANDARD DEVIATIONS (SOFT AND HARD)
• STANDARD DEVIATIONS OF SAMPLES (SOFT AND HARD)
• DELTA COUNT RATES (SOFT AND HARD)
• MACROSCOPIC CROSS-SECTION $U_{ROT\,TOP}$
$U_{ROT\,TOP} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE} - \Delta CR_{SOFT}}{\text{HARD COUNT RATE} - \Delta CR_{HARD}} \right) - B} \right] - C$
• $PEF_{ROT\,TOP} = \frac{U_{ROT\,TOP}}{P_{bROT\,TOP}}$
FROM FIG.10A-2
$P_{bROT\,TOP}$
335
$PEF_{ROT\,TOP}$
SOFT WINDOW COUNT RATE SAMPLES IN Q_{LEFT} LONG OR SHORT
HARD WINDOW COUNT RATE SAMPLES IN Q_{LEFT} LONG OR SHORT
COUNT RATES
FROM FIG.8
DETERMINE:
• THEORETICAL STANDARD DEVIATIONS (SOFT AND HARD)
• STANDARD DEVIATIONS OF SAMPLES (SOFT AND HARD)
• DELTA COUNT RATES (SOFT OR HARD)
• MACROSCOPIC CROSS-SECTION $U_{ROT\,LEFT}$
$U_{ROT\,LEFT} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE} - \Delta CR_{SOFT}}{\text{HARD COUNT RATE} - \Delta CR_{HARD}} \right) - B} \right] - C$
• $PEF_{ROT\,LEFT} = \frac{U_{ROT\,LEFT}}{P_{bROT\,LEFT}}$
FROM FIG.10A-2
$P_{bROT\,LEFT}$
$PEF_{ROT\,LEFT}$

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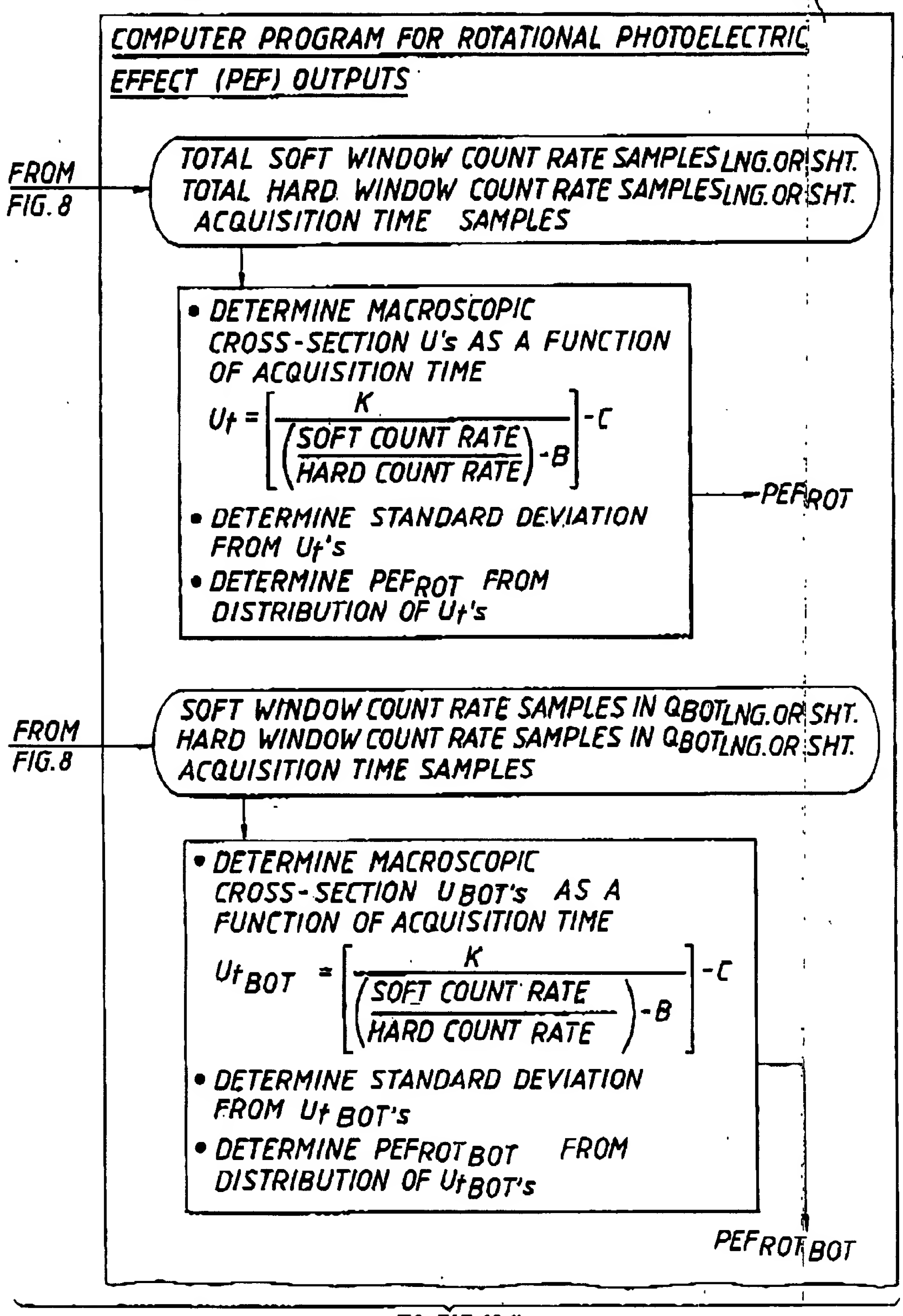
FIG. 12D



TO FIG. 12E

FIG.12E

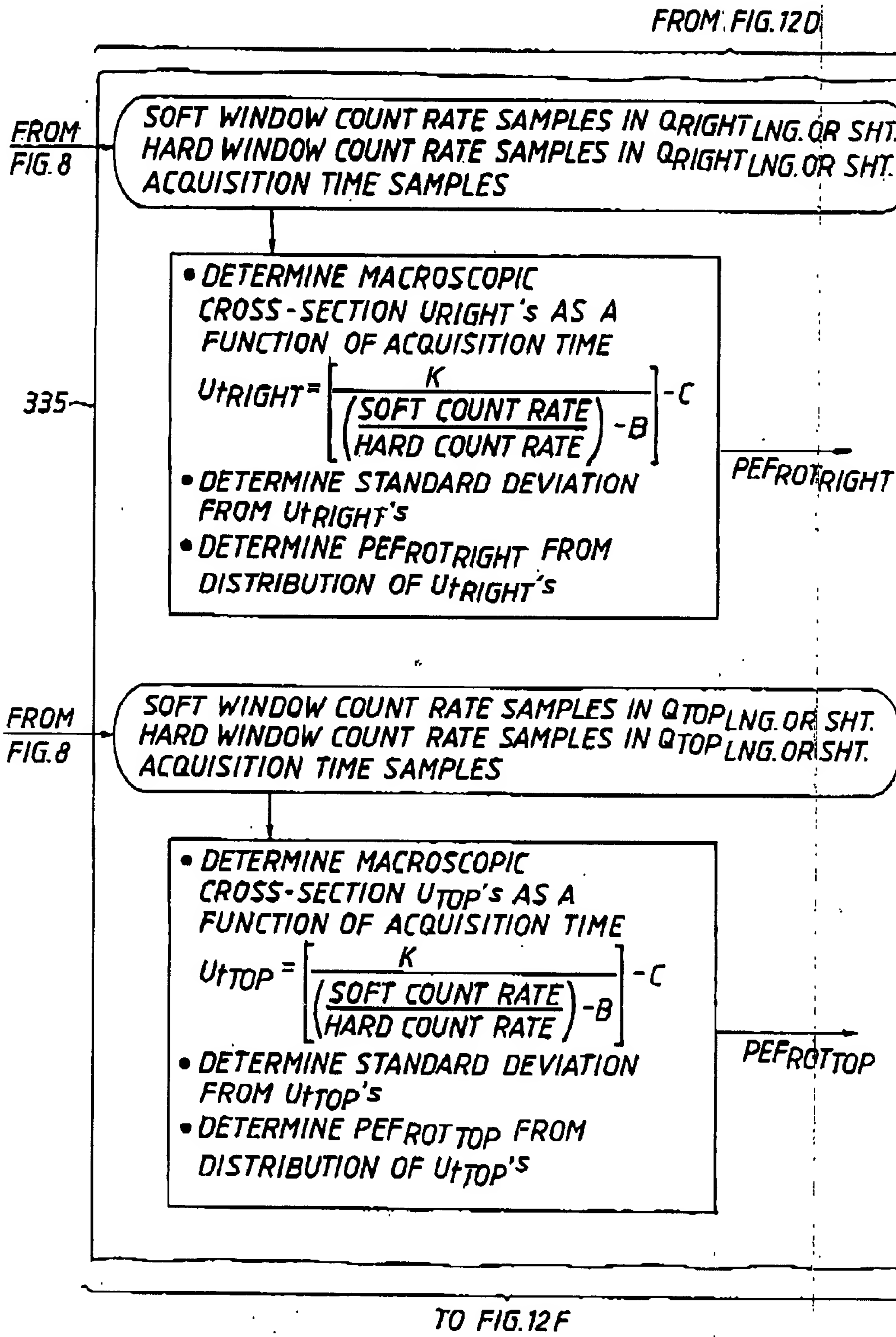

FROM FIG.12D
FROM FIG.8
SOFT WINDOW COUNT RATE SAMPLES IN Q_{RIGHT} LNG. OR SHT.
HARD WINDOW COUNT RATE SAMPLES IN Q_{RIGHT} LNG. OR SHT.
ACQUISITION TIME SAMPLES
335
• DETERMINE MACROSCOPIC CROSS-SECTION U_{RIGHT}'s AS A FUNCTION OF ACQUISITION TIME
$Ut_{RIGHT} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE}}{\text{HARD COUNT RATE}}\right) - B}\right] - C$
• DETERMINE STANDARD DEVIATION FROM Ut_{RIGHT}'s
• DETERMINE $PEF_{ROT\,RIGHT}$ FROM DISTRIBUTION OF Ut_{RIGHT}'s
$PEF_{ROT\,RIGHT}$
FROM FIG.8
SOFT WINDOW COUNT RATE SAMPLES IN Q_{TOP} LNG. OR SHT.
HARD WINDOW COUNT RATE SAMPLES IN Q_{TOP} LNG. OR SHT.
ACQUISITION TIME SAMPLES
• DETERMINE MACROSCOPIC CROSS-SECTION U_{TOP}'s AS A FUNCTION OF ACQUISITION TIME
$Ut_{TOP} = \left[\frac{K}{\left(\frac{\text{SOFT COUNT RATE}}{\text{HARD COUNT RATE}}\right) - B}\right] - C$
• DETERMINE STANDARD DEVIATION FROM Ut_{TOP}'s
• DETERMINE $PEF_{ROT\,TOP}$ FROM DISTRIBUTION OF Ut_{TOP}'s
$PEF_{ROT\,TOP}$
TO FIG.12F

FIG. 12F

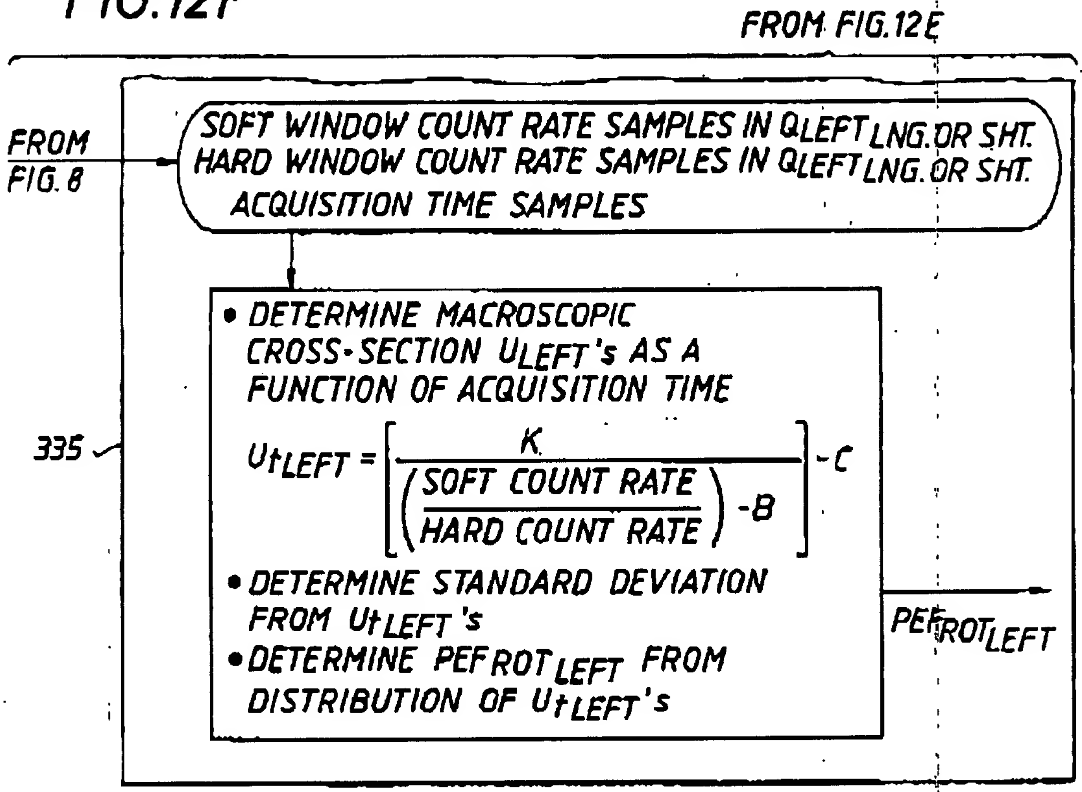


FIG. 13

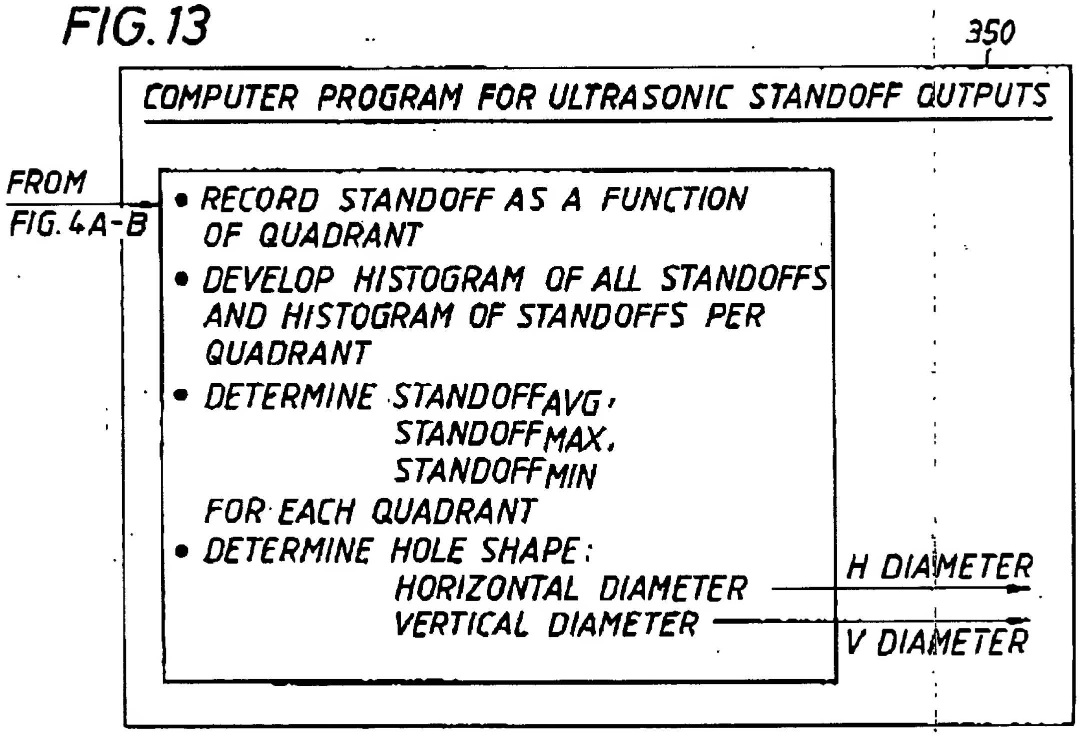
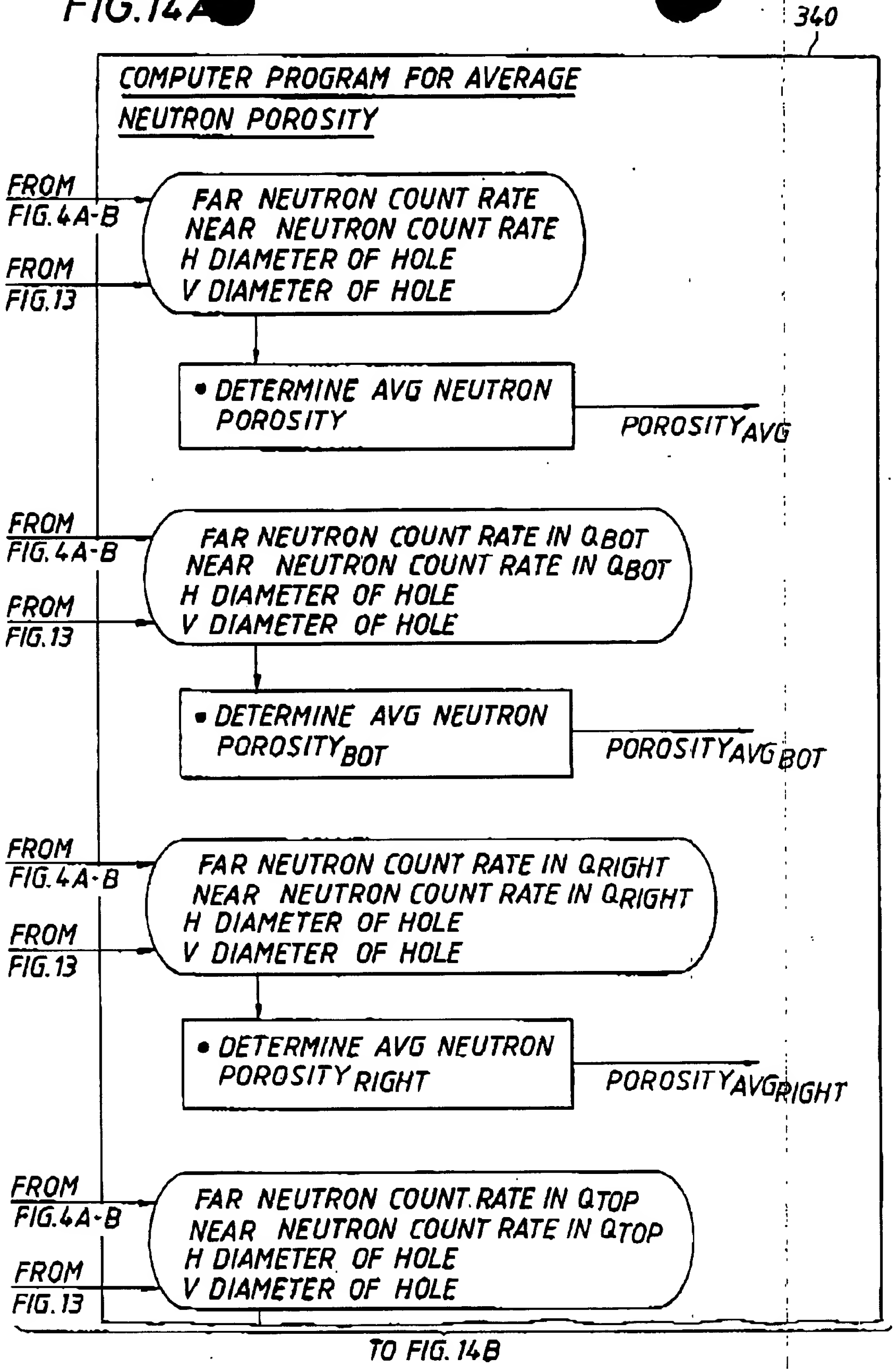


FIG.14A


340
COMPUTER PROGRAM FOR AVERAGE NEUTRON POROSITY
FROM FIG.4A-B
FROM FIG.13
FAR NEUTRON COUNT RATE
NEAR NEUTRON COUNT RATE
H DIAMETER OF HOLE
V DIAMETER OF HOLE
• DETERMINE AVG NEUTRON POROSITY
POROSITY AVG
FROM FIG.4A-B
FROM FIG.13
FAR NEUTRON COUNT RATE IN Q BOT
NEAR NEUTRON COUNT RATE IN Q BOT
H DIAMETER OF HOLE
V DIAMETER OF HOLE
• DETERMINE AVG NEUTRON POROSITY BOT
POROSITY AVG BOT
FROM FIG.4A-B
FROM FIG.13
FAR NEUTRON COUNT RATE IN Q RIGHT
NEAR NEUTRON COUNT RATE IN Q RIGHT
H DIAMETER OF HOLE
V DIAMETER OF HOLE
• DETERMINE AVG NEUTRON POROSITY RIGHT
POROSITY AVG RIGHT
FROM FIG.4A-B
FROM FIG.13
FAR NEUTRON COUNT RATE IN Q TOP
NEAR NEUTRON COUNT RATE IN Q TOP
H DIAMETER OF HOLE
V DIAMETER OF HOLE
TO FIG. 14B

09960445 .092101

FIG.14B

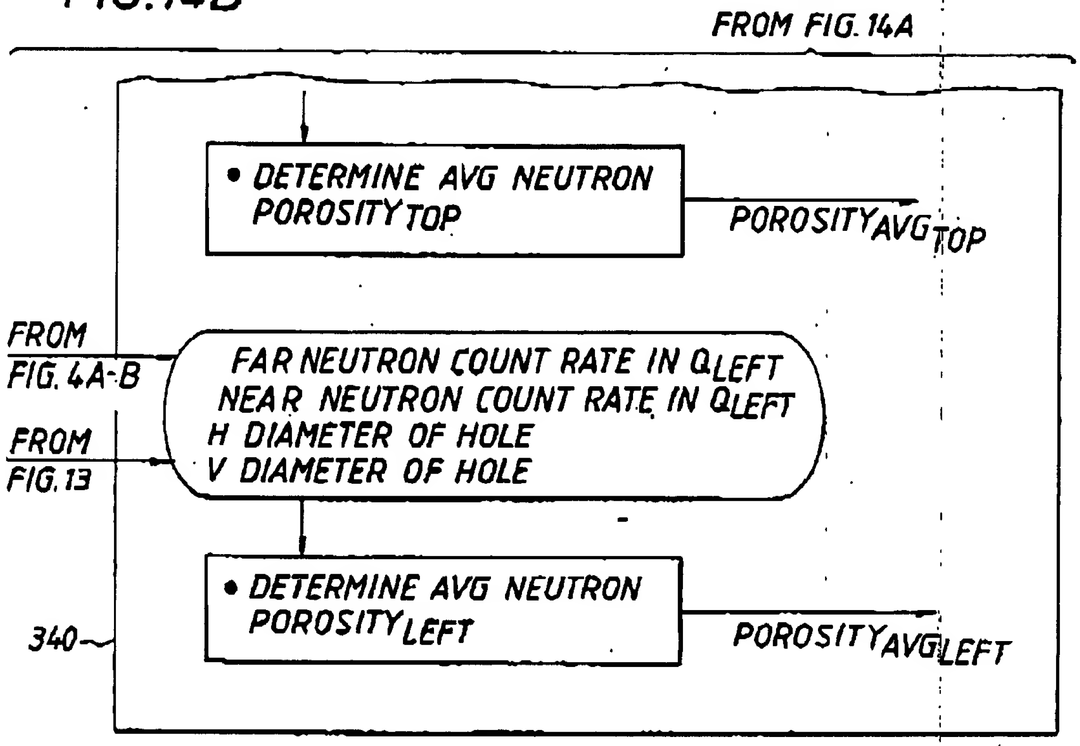


FIG.15A

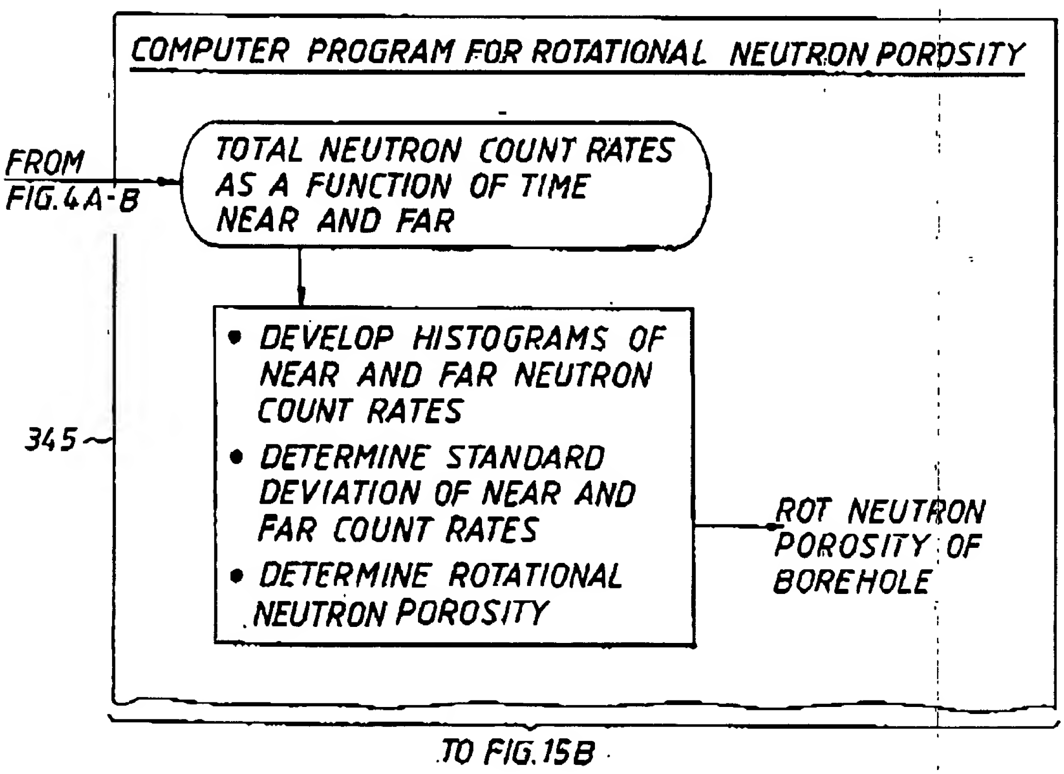


FIG.15B

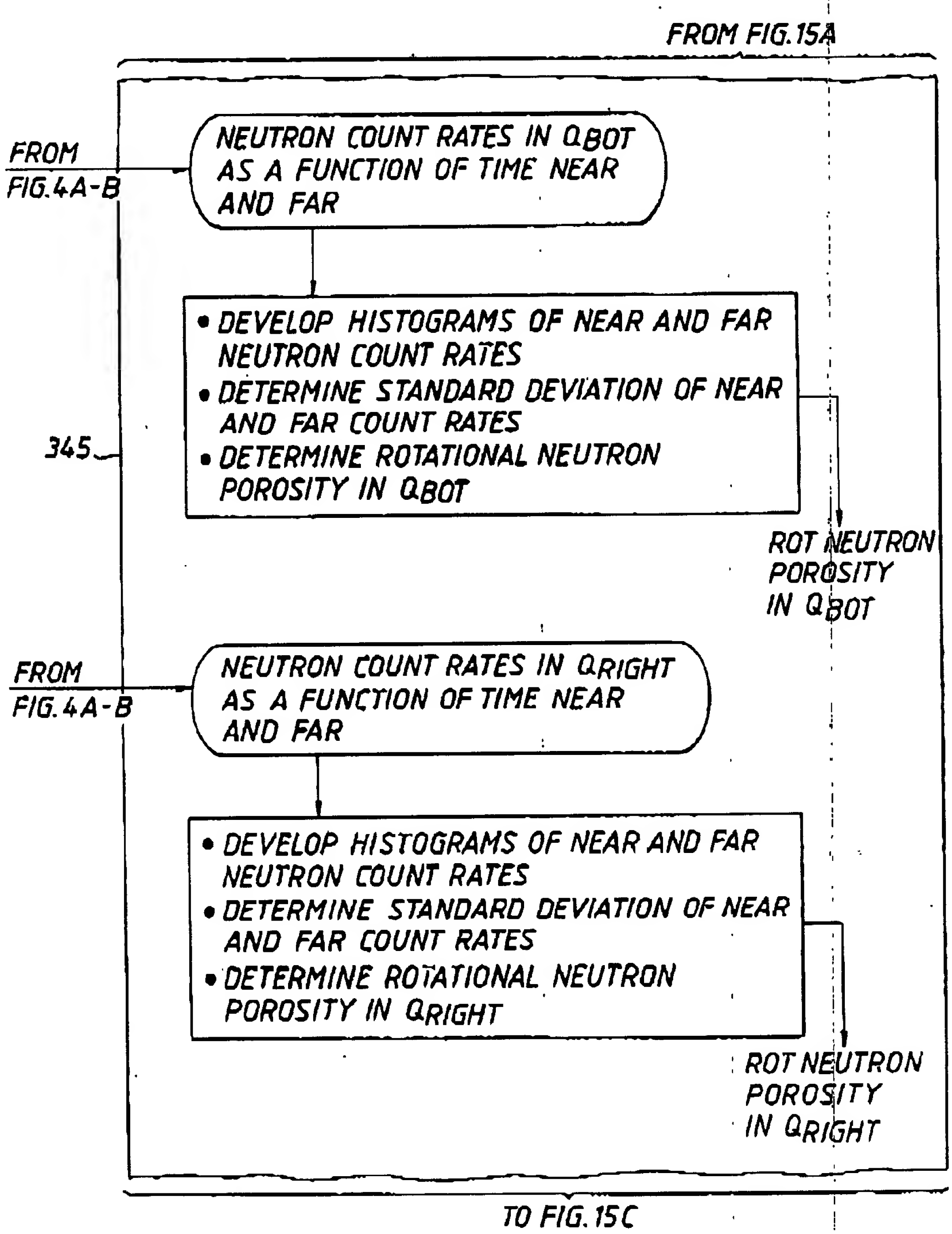
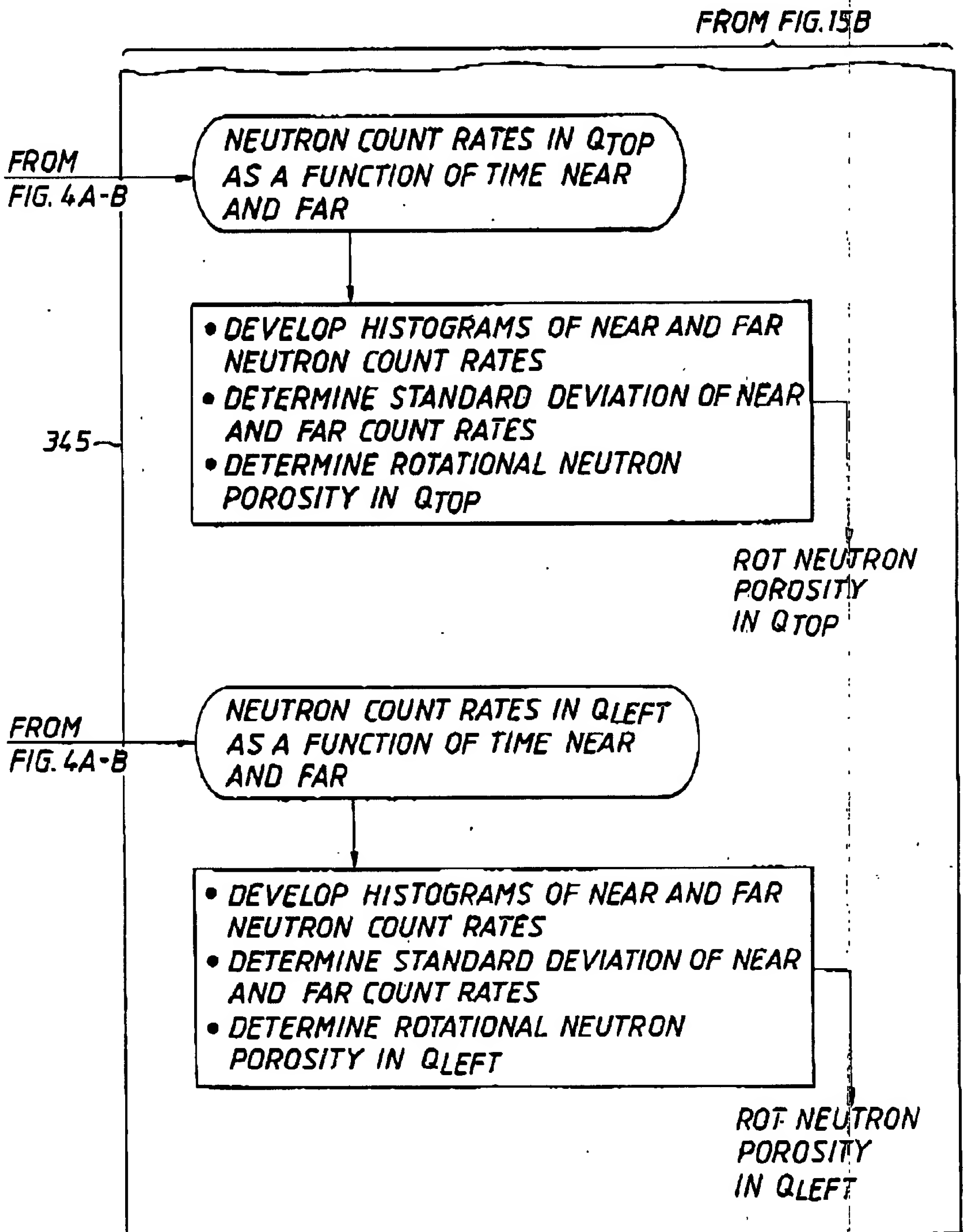

FROM FIG.15A
FROM FIG.4A-B
NEUTRON COUNT RATES IN QBOT AS A FUNCTION OF TIME NEAR AND FAR
• DEVELOP HISTOGRAMS OF NEAR AND FAR NEUTRON COUNT RATES
• DETERMINE STANDARD DEVIATION OF NEAR AND FAR COUNT RATES
• DETERMINE ROTATIONAL NEUTRON POROSITY IN QBOT
345
ROT NEUTRON POROSITY IN QBOT
FROM FIG.4A-B
NEUTRON COUNT RATES IN QRIGHT AS A FUNCTION OF TIME NEAR AND FAR
• DEVELOP HISTOGRAMS OF NEAR AND FAR NEUTRON COUNT RATES
• DETERMINE STANDARD DEVIATION OF NEAR AND FAR COUNT RATES
• DETERMINE ROTATIONAL NEUTRON POROSITY IN QRIGHT
ROT NEUTRON POROSITY IN QRIGHT
TO FIG.15C

FIG. 15C


FROM FIG. 15B
FROM FIG. 4A-B
NEUTRON COUNT RATES IN QTOP AS A FUNCTION OF TIME NEAR AND FAR
• DEVELOP HISTOGRAMS OF NEAR AND FAR NEUTRON COUNT RATES
• DETERMINE STANDARD DEVIATION OF NEAR AND FAR COUNT RATES
• DETERMINE ROTATIONAL NEUTRON POROSITY IN QTOP
345
ROT NEUTRON POROSITY IN QTOP
FROM FIG. 4A-B
NEUTRON COUNT RATES IN QLEFT AS A FUNCTION OF TIME NEAR AND FAR
• DEVELOP HISTOGRAMS OF NEAR AND FAR NEUTRON COUNT RATES
• DETERMINE STANDARD DEVIATION OF NEAR AND FAR COUNT RATES
• DETERMINE ROTATIONAL NEUTRON POROSITY IN QLEFT
ROT NEUTRON POROSITY IN QLEFT

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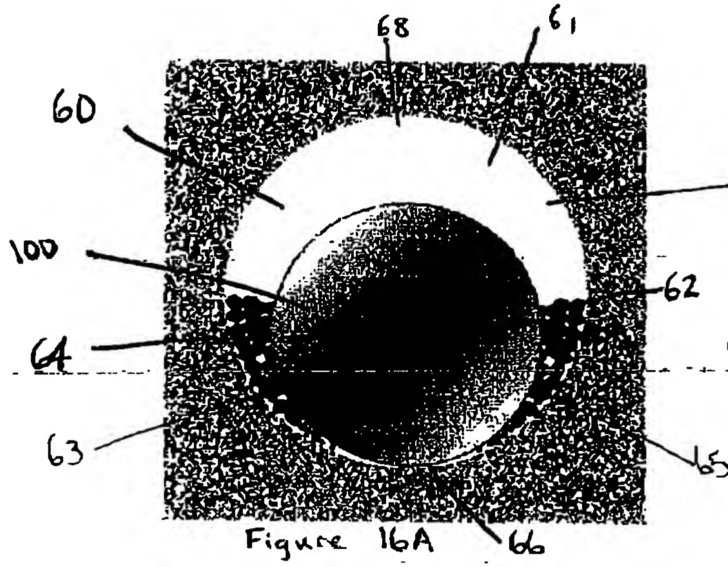

Figure 16A

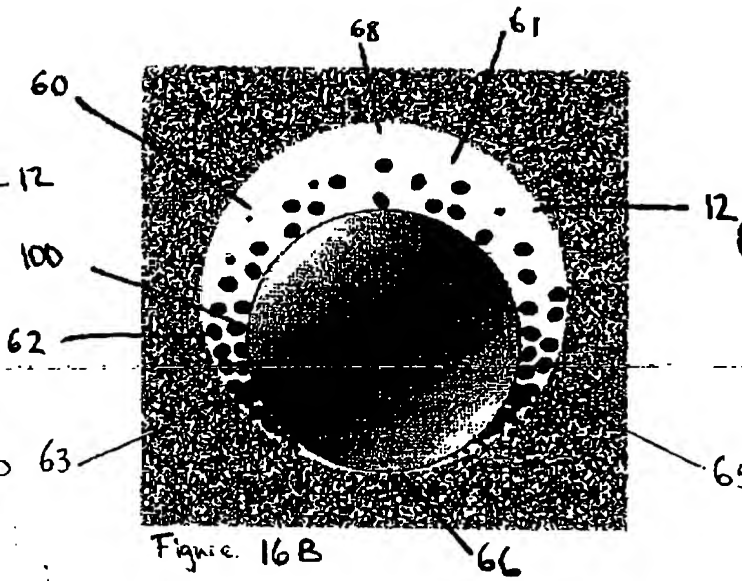

Figure 16B

[redacted]

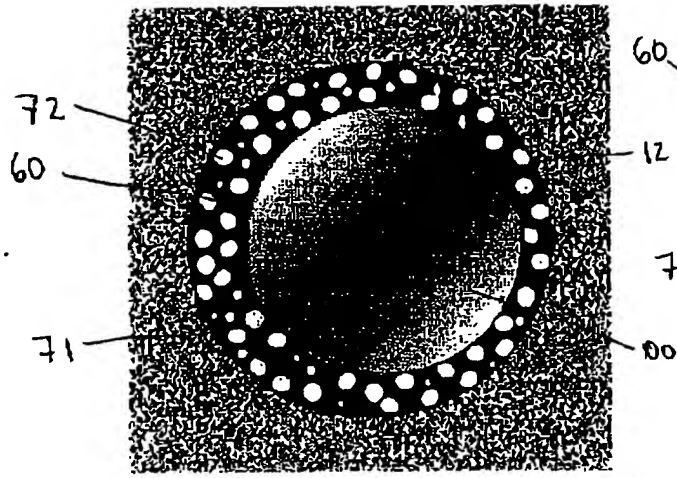

Figure 17A

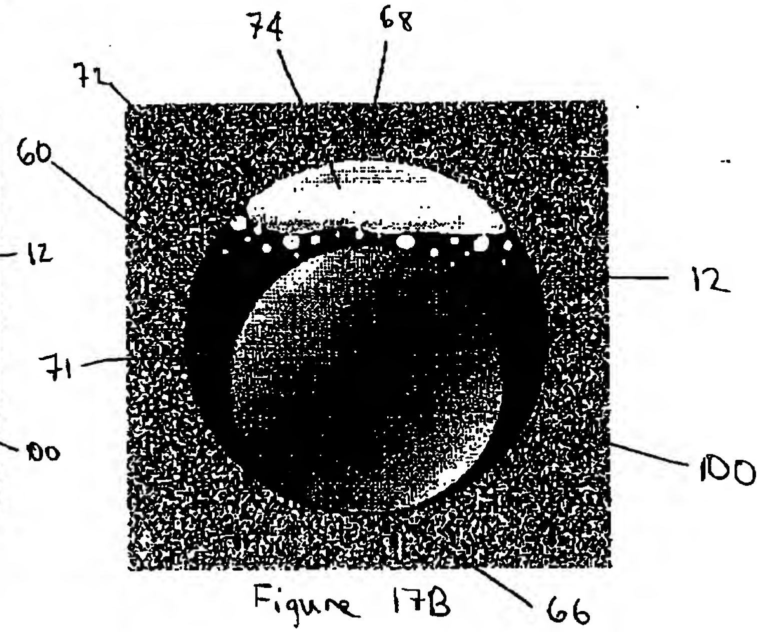

Figure 17B